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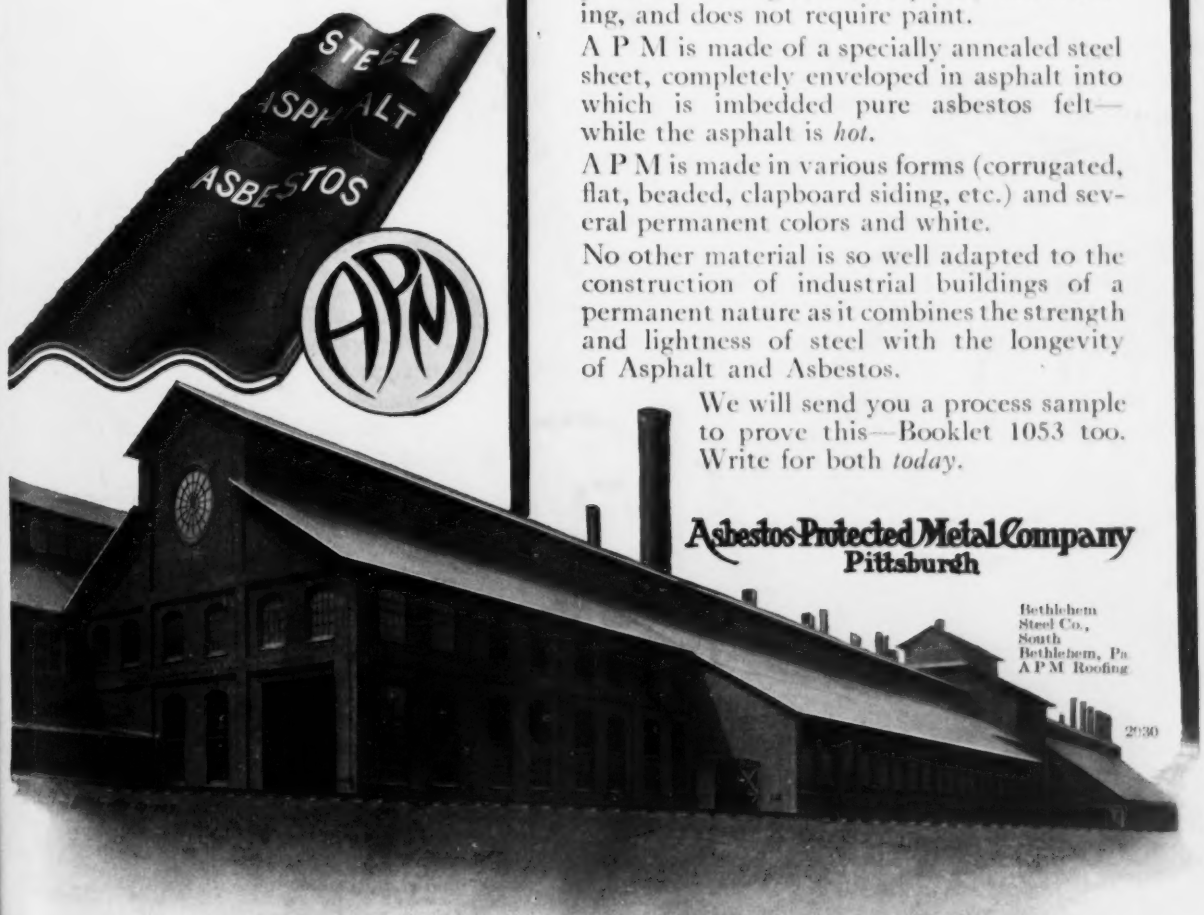

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Engineering News

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Experience and Costs in Making Concrete-Bridge Units

By Horace M. Holmes*

SYNOPSIS—Exceptionally well laid out casting yard. Special measures required in making floor units. Reinforcing steel was bent, wired together in "cages" and set in form as one piece. Number of times forms were used. Concreting economies. Labor cost of making and handling 2,940 piles and 3,665 slabs.

The completion of the long unit-constructed concrete highway trestle across the Yolo bypass in the Sacramento Valley in California is to be celebrated on May 12. The construction of the trestle was treated in *Engineering News*, Feb. 24, 1916, p. 358. The present article tells how the concrete piles and floor slabs were made and how much they cost. The trestle—built for the California Highway Commission—is 3 mi. long and involved the making and driving of 2,940 precast piles, 14x14 in. in section and 32 to 50 ft. long, and the making, handling and setting in the bridge of 3,665 concrete floor units or slabs weighing 5 to 6 tons each. The piles contained 5,170 cu.yd. of concrete and 627 tons of reinforcing steel, and the slabs 10,530 cu.yd. of concrete and 1,118 tons of steel.

For the manufacturing of these piles and slabs a casting yard was located ½ mi. beyond one end of the bridge, the site being the nearest location to the bridge that was protected by a levee from the flood waters of the Yolo flood basin. The important features of the casting yard were the convenient track arrangement, with connections to the Southern Pacific Co., a 1,000-bbl. cement shed, a 250-cu.yd. sand and rock bunker, a 30-cu.yd. per hr. bucket elevator from a track pit to the bunker, a 1-yd. batch concrete mixer and a 20-ton locomotive crane with a 50-ft. boom. The plan of the yard is shown in Figs. 1 and 2.

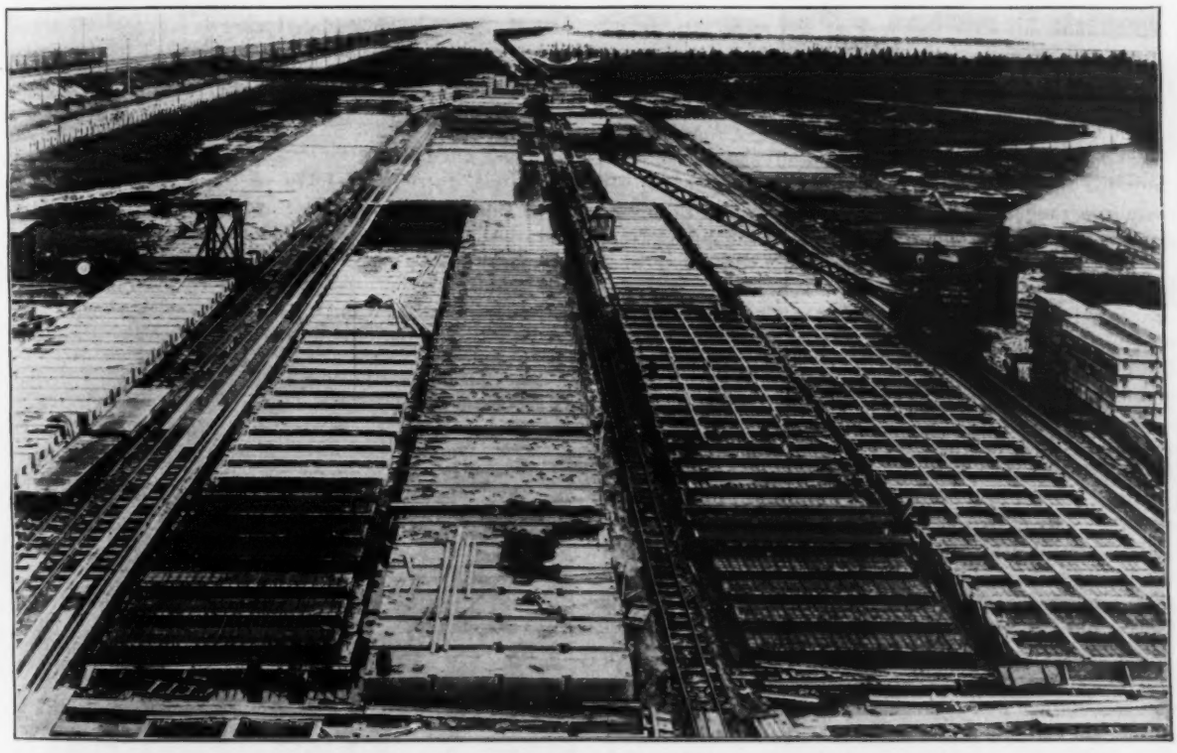


FIG. 1. VIEW OF CASTING YARD FROM SAND AND ROCK BUNKER

*Superintendent of the Graff Construction Co., Seattle, Wash.

For the casting of these 2,940 concrete piles and 3,665 floor units both steel and wooden forms were considered; but it was decided to use 2-in. wooden forms throughout on account of the low cost of lumber and the ease of obtaining it, ease of making alterations and repairs and of increasing the number of the forms needed. The daily

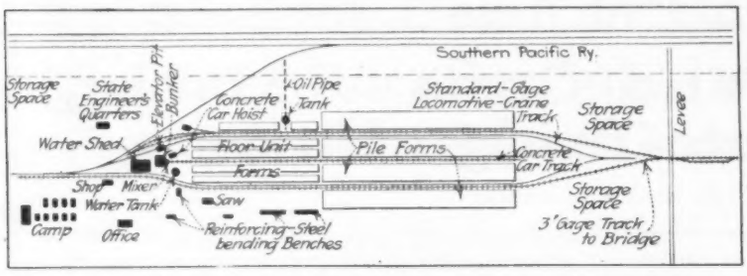


FIG. 2. LAYOUT OF YARD WHERE CONCRETE PILES AND FLOOR UNITS WERE CAST

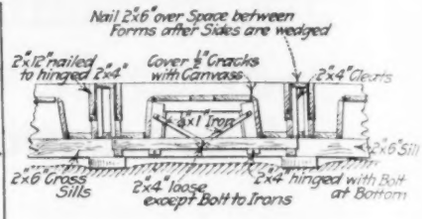

Nail 2"x6" over Space between Forms after Sides are wedged
2"x12" nailed to hinged 2"x4"
Cover 1/4" Cracks with Canvass
2"x4" Cleats
3/4"x1" Irons
2"x6" Sill
2"x6" Cross Sills
2"x4" loose except Bolt to Irons
2"x4" hinged with Bolt at Bottom

FIG. 3. CROSS-SECTION OF FLOOR-UNIT FORM

production of piles was 20, and this in conjunction with the requirement of the specifications that the piles should cure 30 days before being moved from the forms determined that 600 pile forms were necessary. A total of 177 M ft. b.m. of lumber was used for the pile forms, exclusive of the mudsills required. The bottom part of the pile forms was stationary and was used 5 times; as for the side forms, 75 pairs were kept on hand, and these were used 19 times before replacing.

To follow up with the deck at the same rate as the piledriving progressed required floor units for an average of 5 spans per day, or 25 finished floor units per day. The specifications set no length of time the floor units should cure before being removed from the forms, so 10 days was decided to be sufficient, and 250 forms were built for the floor units. The pile and floor-unit forms were so arranged that concrete could be placed in any of them from a bottom-dump concrete bucket hanging from the 50-ft. boom of the locomotive crane; and they were so spaced that when the forms were set up ready for concrete they presented an area that required no close spotting of the concrete bucket, as any excess concrete falling into one form could easily be pushed over into the adjacent form. This arrangement proved of great value in filling the forms. The bottoms of all forms rested on wooden sills, to provide for leveling up with wedges if unequal settlement occurred.

Details of Floor-Unit Forms

The floor-unit forms, on account of the recess between the beams making a space surrounded by concrete on all sides but one, presented the problem of building a form that would not bind with the swelling of the wood and would permit the picking up of the floor unit free from, and without disturbing, this bottom form. The binding due to swelling was overcome by making the sides and ends of the recess form separate from the top and hinging them so that they could be swung slightly away from the concrete as soon as it obtained its initial set (Fig. 3). The method of preparing the floor forms for concrete was as follows: The reinforcing steel for one floor unit, having been bent, made up and wired together in the steel yard, was set as one piece on the bottom of the floor-unit form. The sides of the form were set up and wedged to position and the boards placed over the space between the adjacent forms. Pieces of 2½-in. pipe were placed to form the 3-in. dowel holes, and the form was ready. The pipes for the dowel holes were removed 12 hr. after filling the forms. Also at this time the boards forming the inside surfaces of the beams were loosened. The side forms were removed after 48 hr., and the concrete slabs were picked off the forms and carried to the storage yard at the end of 10 days. The forms were well oiled every other time used and the canvas strips over cracks were painted with tallow. The boards forming the inside surface of the slab were loosened 12 hr. after concrete was poured, so that when required the slab could be picked up without disturbing the bottom form.

The 3,665 floor units were made with but one set of 250 bottom forms, which were filled with concrete 14 times each. Of side forms 85 sets were kept on hand, and these had to be replaced after being used 22 times. Lumber for forms amounted to 166 M ft. b.m. (exclusive of mudsills).

Forms for the Caps of the Bents

As but one-half of the length of the bent cap was cast at a time, there were 1,470 of these half-caps to cast. Each concrete pile when cast was provided with a 1-in. hole through the pile 22 in. below the head. This hole was to contain a bolt to support the cap-form sills. The side forms for the caps were stripped after 48 hr., the bottom forms after 8 to 10 days. The bottom forms were used 10 times, and 140 forms were required; 85 sets of

FIG. 4. COMPLETED YOLO BYPASS CONCRETE TRESTLE IN CALIFORNIA

side forms were used 17 times. There was 33 M ft. b.m. of lumber in these cap forms.

The labor cost of making, setting up and removing the forms for the piles and floor units was 2c. per square foot of concrete surface covered with forms.

The 2,000 tons of reinforcing steel was on the job before any concrete was poured. It was unloaded from the cars by the locomotive crane, special provision having been made to have it shipped with timbers under and between the bundles of bars, to make possible the attachment of the unloading chains.

For both the piles and the floor units the steel for a unit was bent, wired together and entirely prepared on benches and horses in the steel yard adjacent to the forms. These prepared units, or "cages," were transferred from the storage piles in the steel yard to the forms on two-wheeled pushcarts. As an average day's work of bending, wiring together and transferring to storage piles and to the forms, 17 men at a total wage of $52.50 per day would perform these operations on 24 of the 620-lb. floor-unit "cages," and 8 men at a total wage of $28.40 per day would perform these operations on 20 of the 463-lb. 40-ft. pile "cages." As in the case of the formwork, the daily repetition of the same operations resulted in doing exact and low-cost work. The steel for the bent caps was bent in the yard and wired together in bundles for ease of transportation, the assembling being done on the cap form.

Handling Concrete Materials and Casting Units

Sand and crushed rock for the concrete were received in bottom-dump cars and handled by the bucket elevator from a pit to the bunker. From the bunker these materials were handled by gravity into the measuring hopper of the 1-yd. batch mixer. The mixer discharged into a 1-yd. bottom-dump bucket resting on a small flat-car that was transported through the center of the yard by an endless cable operated by a reversible hoist. From the cars the buckets of concrete were handled to the forms by the locomotive crane.

A considerable part of the concreting was done at night, so as to give the crane an opportunity in the daylight to load for transportation the cured piles and floor units. As fast as the piles and floor units cured, they were lifted from the forms by the crane and transported to storage piles at one end of the yard, from which they were loaded as needed. No difficulty or breakage was experienced in the general practice of picking up the floor slabs from the forms on the eleventh day after they were cast. A double sling with spreader was used on the crane fall block, so that the stress was vertical from the lifting eyes of the floor units. The piles were lifted with a double sling hooked around the piles at about the quarter-points.

The concrete piles and floor units were hauled from the casting yard to their place in the bridge on a single track of 3-ft. gage, with passing tracks as needed, using a 5-ton and a 7-ton gasoline locomotive made by the Milwaukee Locomotive Co. A summary of this hauling is as follows:

Item	Labor Cost of Loading and Hauling	Tons Hauled	Ton-Miles of Hauling	Labor Cost per Ton-Mile
2,940 concrete piles..	$1,918	10,467	26,482	$0.073
3,665 concrete slabs..	1,770	21,317	53,932	.033
	$3,688	31,784	80,414	$0.046

To keep the track clear for serving the piledriver, the setting of the floor units was somewhat hindered and was more or less intermittent. In one run of eighteen 8-hr. shifts 897 floor units were unloaded by the traveler and set in the trestle by a gang of 11 men at a labor cost of 15c. per ton for 4,777 tons. Placing the tie-plates between the slabs and filling the joints with grout for these 897 slabs cost 13c. per ton of slabs handled.

The contract for the construction of the concrete trestle was executed by the Graff Construction Co., Seattle, Wash.

Iron- and Manganese-Removal Tests, Lawrence, Kan.

Tests of the removal of iron and manganese from water by aëration, sedimentation and filtration were made at Lawrence, Kan., in the summers of 1914 and 1915. These tests gave such encouraging results that the city feels warranted in constructing an iron-removal plant and has recently asked engineers to apply (up to Apr. 24) for the task of designing and constructing it.

The Lawrence tests were made by the State Chemical Research Division of the University of Kansas, W. A. Whitaker, Director, by James Schwab. Prof. C. C. Young, of the Water and Sewage Laboratory of the State Board of Health, assisted in directing the work. Prof. C. A. Haskins is engineer of the Water and Sewage Division of the Board. The notes here given are the substance of a summary of the tests soon to appear in Engineering Bulletin No. 7 of the University of Kansas:

The water for the City of Lawrence, Kan., is secured from wells 35 to 50 ft. deep, piercing the débris deposited by the Kansas River. This water is quite hard and contains large quantities of iron in solution, varying from 11 to 20 p.p.m., and also contains about 1 p.p.m. of manganese. A treatment consisting of a limited aëration and 48 hr. sedimentation on the continuous-flow plan, in uncovered basins, removes a large part of the iron, but there is an average remaining of 4 to 6 p.p.m.

The experimental plant consisted of an aërating tower, sedimentation basin and rapid sand filter. The aëration tower was 3 ft. in diameter by 10 ft. high and was constructed of galvanized iron. The sedimentation basin consisted of eight 50-gal. barrels connected in series. The filter was a 1x2x10-ft. galvanized-iron tank, fitted with Wheeler underdrains, a wash-water trough, loss-of-head gages and 30 in. of sand with an effective size of 0.35 mm. and a uniformity coefficient of 1.7.

Ten experiments were attempted for removal of iron by plain aëration, sedimentation and filtration, and by aëration on coke breeze, sedimentation and filtration. From these experiments the following conclusions were drawn: 1. Lawrence water can be freed from iron by aëration, sedimentation and filtration. 2. Two hours' sedimentation in well-baffled basins, after aëration and before filtration, should be allowed. 3. Rapid sand filters may be used at higher rates than are ordinarily accorded for filtering water for bacteria removal. 4. The manganese is only slightly affected by the treatment. 5. The coke trickling filter is an efficient aërator and is an excellent pre-filter, but is not necessary to precipitate the iron. 6. The manganese is not reduced by the action of the coke trickling filter, except for the slight removal affected by aëration. 7. The coke filter may be used continuously over long periods of time before the deposits become so thick that it breaks and requires flushing.

Ballasting Track by Contract

SYNOPSIS—How a new system of letting contracts for track-ballasting worked on the Missouri Pacific Ry.

Ballasting railway track by contract under a system that includes the excavating, loading, hauling, distributing and placing of the ballast is a very unusual feature in railway-maintenance work. It is even more unusual than the mere placing of the ballast by contract, which method has been employed to a limited extent. The comprehensive system first noted was employed on an extensive mileage of the Missouri Pacific Ry. during 1910-11. This is believed to be the only case where such a comprehensive system of ballasting by contract has been employed by a trunk-line railway.

There was a marked saving in cost as compared with similar work done by company forces in the ordinary way. The results were satisfactory, but the system was abandoned owing to a reorganization of the railway. There was some opposition to it at first; the operating department was inclined to regard the handling of contractors' trains as a hazard to traffic, and the maintenance department held that ballast could be put in the track better and more cheaply by the railway forces than by a contractor. The results of experience, however, were considered to show that these objections were without good foundation.

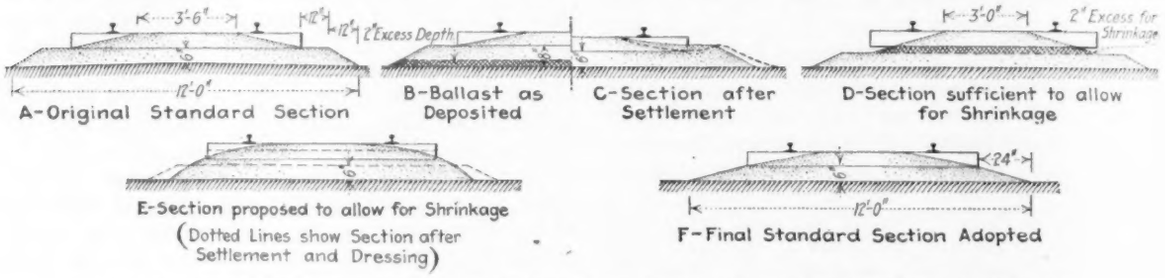
In 1908 the Missouri Pacific Ry. had about 1,800 mi. of main line ballasted only with earth and requiring proper ballast. The company's force and equipment being insufficient to carry out the work as rapidly as desired, it was suggested that the ballasting might be done by contract. M. L. Byers was at that time Chief Engineer of Maintenance of Way, and R. H. Ford was Principal Assistant Engineer.

Inquiry failed to provide information as to similar practice on other lines, so the method of putting the plan into effect had to be worked out as a new problem. Several contractors were invited to bid and were taken over the lines, but most of them considered the method impracticable and only two submitted bids. The first contracts were let to the L. J. Smith Construction Co., of Kansas City, Mo., and later the Hodges-Downey Construction Co., of Birmingham, Ala., took some of the work. The contracts were continued from year to year for three years. The former company ballasted about 1,500 mi. of track, and the latter about 500 mi.

The railway company's standard construction contract was employed, being modified to suit the special conditions. It provided (as for other work) that the company should have the right to employ at the contractor's expense such men and means as its engineer should consider necessary to complete the work within the time limit. Also that in such case it might make use of the contractor's plant. The contract specified the stretch of line to be ballasted and the location of the ballast pits. It divided the price into two items—one for loading, hauling and unloading, the other for applying the ballast (including the raising of track). A separate item covered the renewal of ties.

The contract provided that where the ballast was hauled and applied by the contractor, the quantity paid for would be that required for the minimum ballast section (on a drawing that formed part of the contract), regardless of any excess that might be unloaded. Where the ballast was hauled and unloaded by the contractor and applied by the company, the quantity paid for was to be on the basis of car measurements made at the point of unloading by the engineer.

Payment for extra work was to cover the cost of labor only, plus 10% for supervision and use of tools. Where materials and supplies were used in such work, these were to be paid for at actual cost, with no additional allowance. Payments were to be made monthly, 10% of the monthly estimate being deducted and held until the completion of the contract. To insure good work and the proper tamping of the ties, the contractor was required to maintain the track in line and surface for a sufficient period after the placing of the ballast. This period depended on the traffic, but was usually about ten days.



BALLAST CROSS-SECTIONS DURING BALLASTING BY CONTRACT ON THE MISSOURI PACIFIC RY.

Under these contracts the payment was on the basis of a certain quantity of material per mile of track. Trial was made of payment on the basis of yardage, or the quantities actually placed. This did not prove very satisfactory. It was found best for the railway company to state the desired number of yards per mile for its standard ballast section, and if any additional amount was required, to have this placed by regular authorization, the same as extra work is paid for on construction contracts.

Ballast Pits and Track Connections

The railway company provided land and right-of-way for the ballast pit, but the contractor had to furnish at his own expense all temporary rights across private property to give access to his work.

The company provided at or near the gravel-pit storage tracks (usually with capacity for 50 cars) and at the

junction with the main line sufficient tracks to handle the arriving and departing ballast trains. All other tracks were constructed and maintained (and shifted as required) by the contractor at his expense, except that the company lent him the necessary track materials free of charge. The haul from ballast pit to the work ranged from 2 to 250 mi., averaging about 90 mi. The number of ballast trains was from one to four daily.

Most of the ballast was gravel, and this was mainly loaded by steam shovels into Rodger ballast cars. It was discharged by means of a plow and cable operated from an unloader engine on a car next to the locomotive. These cars averaged 35 cu.yd. each. On some of the work chats (or zinc-ore tailings) was used. In this case the railway company loaded and hauled the ballast, delivering the trains to the contractor at a siding near his work. An inspector at the pit made the necessary measurements of loaded cars.

Locomotives and Equipment

All locomotive equipment and tools were provided by the contractor, except that the company furnished from its own equipment (and free of charge) a sufficient number of ballast cars, unloaders and plows, as determined by the engineer. The contractor was required to keep in repair all the railway equipment thus supplied and to return it in good condition (with allowance for deterioration). The company had the right to make repairs and deduct the cost from the amount paid to the contractor.

Locomotives and other equipment were required to comply with the safety-appliances law and to be subject to the approval of the railway company's superintendent of machinery. Damage to equipment in main-line movement was borne by the owner of the equipment, while the contractor was responsible for such damage outside of main line.

The company agreed to furnish bunk or boarding cars, water cars and cabooses not needed for its own use; no charge was made for them, but the contractor was required to release them on 30 days' notice if required. The contractor kept them in repair, and if they were moved over the line he saw that they were in safe and proper condition. Water was furnished free, except that where the company had to purchase it the contractor was billed for water taken at the same rate paid by the company.

Where the contractor required extra equipment or the railway called on him for extra work that necessitated the use of his equipment (exclusive of labor and force), the following daily charges were made: Locomotives, $10 with cylinders to 18-in. or $20 with 18- to 22-in. cylinders; steam shovels, $15 for 40- to 60-ton, $18 for 60-ton and over; derrick cars (including tool and blocking cars), $20; wrecking cars, $30 for 30-ton, $40 for 40- and 50-ton, $50 for 78-ton and over.

Train Service and Operation

The handling of the ballast trains was under the direction of an assistant trainmaster, whose whole time was assigned to this work. The railway company furnished at its own expense all the appliances and operators necessary for the handling of the contractor's trains on main lines, the men being under the jurisdiction of the superintendent. The company also provided the same facilities for the contractor's trains as for its own trains in similar service for movement over main, passing, side or spur tracks, giving such preference to the contractor's trains as to avoid unnecessary delay. The company further agreed to keep its passing tracks within the ballasting limits as clear of cars as practicable, in order to aid the movement of the ballast trains. The number of these trains averaged two per day.

The contractor agreed to bear all loss resulting from delays, however caused (in movements over the company's tracks, awaiting orders or moving when but partially loaded). All train movements were subject to the rules and regulations of the company. Trains outside of the ballast-pit limits (indicated by a signal near the junction with the main line) were under the direction of the superintendent or his trainmasters and dispatchers.

The contractor was required to protect the line when applying ballast, posting flagmen at proper distance in each direction. These men were furnished by the company, but were paid by the contractor and practically in his employ. The company supplied enginemen and trainmen for main-line movements. It also appointed an assistant trainmaster (approved by the contractor) to supervise such movements as noted. The pay of the enginemen and trainmen and half the salary of the assistant trainmaster was deducted from the monthly estimates of the contractor. He was made responsible for deaths, injuries or damage to property due to defective equipment, while the company was responsible for such matters in main-line movement due to negligence of enginemen or trainmen.

Contract Prices for Ballasting

The prices of the contracts varied slightly according to the length of haul and other conditions. In one contract, which serves as an example, the prices and conditions were as follows:

For loading and hauling ballast (gravel) from the ballast pit and unloading it at the point of application, 52c. per cu.yd. For applying ballast, 25c. per cu.yd. Where the ballast was hauled and applied by the contractor, the quantity paid for was that called for by the minimum ballast section, shown on the accompanying plan (1,411 cu.yd. per mi.), regardless of any excess unloaded by the contractor. Where the ballast was merely hauled and unloaded by the contractor and applied by the company, the quantity paid for was on the basis of car measurement made at the point of unloading by the engineer.

For renewing ties (including the necessary respacing), 15c. per tie renewed; ties to be furnished by the company.

On a contract where chats was delivered to the contractor in train loads (ballasting dump cars) the prices were 64c. and 79c. per yd. for hauling (from point of delivery) and unloading and 30c. for applying. The high price for hauling was due to increased length of haul.

The earlier contracts required the ballast to be trimmed to the minimum cross-section shown at *A* in the accompanying drawing. This required 1,411 cu.yd. per mi. The specifications provided that ballast should be unloaded sufficient to bring the track to the minimum section. Where an excess amount was unloaded, the contractor might either use it to fill in at the points marked by dotted lines (at *A*) or remove it for other use. In either case he was paid the contract price for loading, hauling, unloading and applying ballast called for by the

minimum section, no payment being made for excess or for labor in moving surplus ballast to other points.

The ballast was applied so as to give a 6-in. lift to the track. After being applied, or put under the ties, the track was lined to the center stakes, the contractor being paid for the extra cost where the track had to be moved more than 12 in. The ballast was then dressed to the finished cross-section. On approval by the engineer, the track was accepted by the company, which was not required to accept it in less than 5-mi. sections.

The method of applying the ballast and at once dressing it to the standard section proved unsatisfactory and led to controversy due to the shrinkage of ballast, as will be noted. In later contracts the cross-section was as shown at *F*. These contracts provided that the ballast should be distributed in quantity sufficient for a 6-in. finished lift, but should be applied in two lifts. The first, or rough, lift was to be sufficient to place not less than 4 nor more than 5 in. of ballast under the ties. The track was then left for settlement under traffic, being kept in such condition as to allow of a speed of at least 25 mi. per hr.

After sufficient time for settlement, the track was surfaced, lined and left in as good line as possible without the aid of center stakes (except where the company considered these necessary). If the track had to be thrown more than 12 in., the contractor was paid for the additional cost. Finally the track was given a finished lift of 1 to 2 in. of ballast, to bring it to grade. The ties were then thoroughly tamped, the track brought to finished line and surface, and the ballast dressed to the standard section.

Clearing the old earth ballast from between the ties in readiness for the new ballast (known as skeletoning the track) was done for such distance in advance as the engineer considered would be safe and not interfere with the use of the track. This distance ranged from one to four miles. The contractor removed all material to the level of the bottom of the ties, using this to widen or fill depressions in the roadbed.

The railway company kept close supervision of the work, its inspectors being on hand at all times to check the unloading, ballasting and all track work.

Shrinkage of Ballast

On one of the earlier contracts controversy arose over the quantity to be paid for, the contractor claiming that the final estimate did not include the full amount deposited to bring the track up to the required grade. In this case the contract specified a certain ballast cross-section and a raise of 6 in. for the track. The amount thus called for was 1,411 cu.yd. per mi., but the contractor claimed that a considerably greater quantity was required. The trouble appears to have been due to the settlement of ballast taken from the pit that served this contract, the same trouble not being experienced elsewhere.

The settlement was from 1½ to 2 in. and was so general that the engineers in the field, after setting stakes to grade, gave the contractor's foremen 2-in. blocks to place upon the stakes when distributing gravel. This means that 8 in. of ballast had to be put into the track to give the required 6-in. depth after the settlement. The additional material was applied for the full width of the roadbed, as shown at *B*, giving 310 yd. in excess, or 1,721 yd. per mi. It was really needed, however, only under the tie, as at *D*, involving 170 yd. excess, or 1,581 yd. per mi.

The settlement disturbed the normal ballast section, as shown at *C*, the ballast settling only under the ties. The engineer proposed therefore that the ballast should be filled in roughly to raise the track 6 in. plus the shrinkage, as at *E*, and then left to settle under traffic. When it had come down to the 6-in. thickness it could be trimmed to the standard cross-section, shown by the dotted line. The plan adopted, however, was to deposit the ballast in two lifts (as already described), and to finish it to the cross-section shown at *F*.

Renewing Ties and Other Work

The railway company marked such ties as were to be removed and supplied the ties and spikes for renewal. The contractor removed the marked ties, placed the new ones and respaced all ties at the rate of 18 per 30-ft. rail length. Ties were required to be placed square across the track and properly spiked. Old ties were removed to the side of the roadbed and burned or otherwise disposed of. Old spikes in good condition were utilized.

During the work suitable runoffs were made for safe passage of trains onto and off the ballasted track. The contractor was required to keep public and private crossings, streams and ditches clear of ballast or other obstruction. The company undertook to raise all bridges and culverts in advance of the ballasting; the necessary runoffs at the approaches were paid for by the contractor if within the limits of his work or by the company if beyond these limits.

Progress records were made on blueprint charts showing a series of straight lines for the railway, with stations and mileposts marked. A dotted line indicated ballast deposited, a narrow full line indicated the rough list, and a broad full line indicated the finished lift. Colors indicated the weekly progress.

A Remarkable Oil Well near Tampico, Mex., completed on Mar. 10 by the Huasteca Co., subsidiary of the Mexican Petroleum Co., 120 Broadway, New York City, is described in the "Mexpet Record" for March. This well, which is known as "Cerro Azul No. 4," has a measured daily output exceeding 260,000 bbl. of 21° Bé. oil. The well was drilled to caprock in 1915, and the well casing was cemented and tested to a pressure of 1,050 lb. per sq.in. Further drilling was suspended on account of disturbed political conditions, but was resumed shortly after the recognition of Carranza. A pocket of gas, which was struck on the night of Feb. 9, blew the water out of the well; and almost as soon as drilling began the next morning, a great body of gas was struck, blowing the drill, weighing two tons, to such a height that it landed 41 yd. away from the well. The drilling cable thrown up with the tools became so twisted about the head of the well when the tools were thrown out that the valve which had been placed on the head of the well was torn off. The crown of the derrick was carried away, and the escaping gas demolished a considerable part of the rest of the structure. About the middle of the afternoon the jet of escaping gas was followed by oil, which rose to a maximum height of 600 ft. Nearly a million barrels of oil was thrown out of the well before it could be closed. In order to save some of the oil, which was overflowing all the surrounding country, native laborers were brought in and set to work damming up a ravine. The flow from the well was so rapid, however, that the workmen could not build the dam as fast as the oil accumulated, and about half a million barrels flowed away and were burned. In closing the well, heavy tongued-and-grooved clamps were placed on the well casing, and a valve was connected to these clamps and slid over the well by means of a screw. The valve was of course open, so that the stream of oil escaped through the valve after it was in position. After it was securely bolted in place, a piece of gas pipe about 30 ft. long was attached to the valve stem, so that the workmen could stand at a safe distance away while they closed the valve.

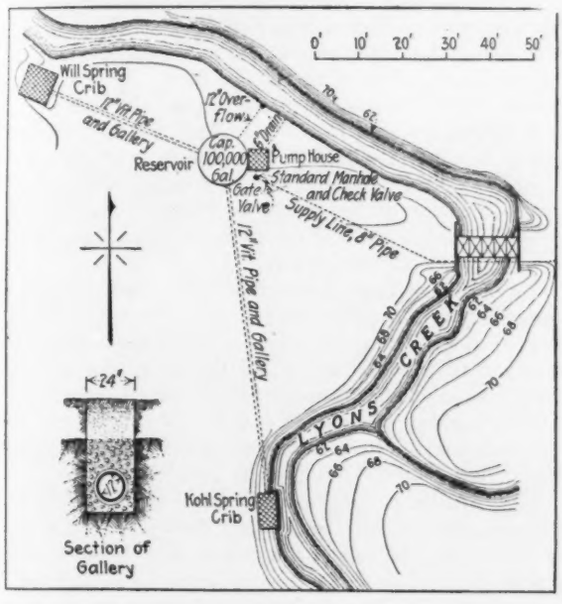
Water-Supply of 500,000 Gal. Daily from River Springs

At Herington, Kan., is an unusual water-works plant. It was completed about a year ago to replace a previous supply from driven wells, which was exceedingly hard and generally unfit for potable use.

The new supply is from springs about 3 mi. west of the city. These springs crop out on the banks and bottom of the creek in two groups about 425 ft. apart (Fig. 1). Reinforced-concrete walls were built around each group of springs and the inclosure roofed in (Fig. 2). The walls were carried well above high water and were made water-tight, to prevent contamination of the spring water with the creek water.

Water flows from the spring houses to a covered collecting reservoir of 100,000 gal. capacity (Figs. 1 and 3). The conduits from the springs to the reservoir are of 12-in. vitrified tile, a portion of which was laid with open joints to allow the infiltration of spring water encountered in digging the trench. This section was inclosed in gravel and sand filling, as shown in the detail in Fig. 1.

The reservoir is covered with a water-tight roof slab of reinforced concrete 6 in. thick, strong enough to withstand the pressure of 10 ft. of water over it, as it must frequently do when the creek is in flood. A vertical vent



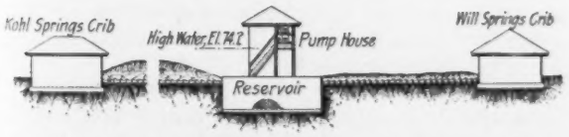


FIG. 1. PLAN AND PROFILE OF HERINGTON, KAN., WATER-SUPPLY

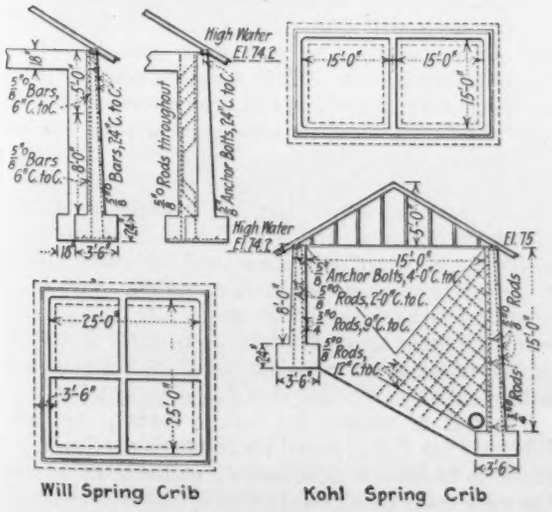


FIG. 2. DETAILS OF SPRING HOUSES

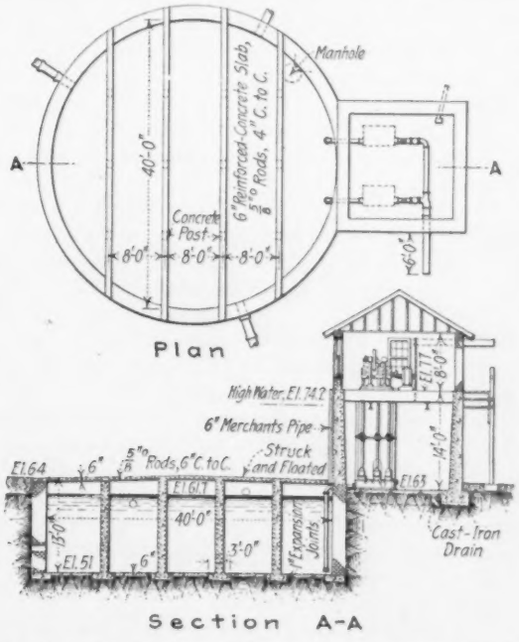


FIG. 3. RECEIVING RESERVOIR AND PUMP HOUSE, HERINGTON WATER-WORKS

pipe is provided along the side of the pump house, to prevent the formation of a partial vacuum in the reservoir, when it is drawn down. The water level in the reservoir never rises to the roof, as an overflow pipe is provided about 2 ft. below the roof.

The pump house is adjacent to the receiving reservoir. The lower walls of the pump house are of reinforced concrete and water-tight, to keep out the flood waters of the creek. The pumping plant consists of two triplex pumps, with extended barrels 15 ft. below the floor. One pump has a capacity of 150 and the other of 250 gal. per min. They are driven by slip-ring electric motors controlled from the municipal electric light and power plant. There is also an automatic shut-off in case the water in the receiving reservoir becomes too low.

The wells flow at a rate of between 400,000 and 700,000 gal. per day. The pumps deliver this water into an 8-in. force main under 225 lb. pressure and supply a city of about 3,500 people. The Benham Engineering Co., Oklahoma City, Okla., did the engineering work for the plant.

Freight Passing Through Canals at Sault Ste. Marie. in 1915 amounted to 71,290,304 tons valued at $882,263,141. The average haul was 832 mi. This tonnage exceeded that of 1914 by 15,920,370. The heaviest tonnage passed through the canal in 1913. It amounted to 79,718,344 tons.

Caliche Roads; A New Type of Construction in Arizona

SYNOPSIS—A cemented conglomerate, blasted from pits, is broken by sledge hammers. Resulting fragments over 4 in. in diameter are rejected. When an extra-good job is desired, the broken material is then spread on the road in layers, flooded, or "irrigated," then floated or dragged, after which the road is ready for traffic.

Except in the suburbs of Phœnix there do not exist any country-road improvements of the pavement types in the State of Arizona. The County of Yuma, in the southwest corner of the state, has just commenced the construction of a system of asphaltic concrete roads (warrenite and bitulithic) which will be practically the only road improvements of the pavement type. In other parts of the state such excellent natural road-building materials exist that there is little need for expensive pavements.

These natural materials are disintegrated granite and gravel, common to most of the mountain states, and in southwestern Texas and southern Arizona a material locally known by the Mexican name "caliche." This is a cemented conglomerate that occurs in pockets, or deposits, like gravel. It is essentially different from the gravel conglomerates frequently found in the Rocky Mountain States in the character of the aggregates composing it. The fragments of stone are sharp and angular and of all sizes. Fig. 1 gives some idea of the sharp edges of these stones. The size of the largest pieces shown is about 12 in. The stone is hard and tough and seems to be of the same nature as traprock. A pile of it looks very similar to crusher-run stone.

This material is so hard and compact that it has to be blasted (with black powder) in excavating the pits. The lumps are then broken up with sledge hammers. Fig. 2 shows a typical caliche pit on the road between Phœnix and Tempe. The cementing material appears to be rock dust and lime. Some of the caliche contains much more lime than others. That containing the most is nearly white and the cementing material has the appearance of hydrated lime.

The larger pieces of stone are thrown aside. It is intended to allow no pieces over 4 in. in diameter to get into the road surfacing. A layer of this material on a prepared subgrade packs very readily and in time forms an almost perfectly smooth-wearing surface. Even in carting the material a distance of a few miles, it becomes partly cemented together in the wagon body, so that it is necessary to break up much of it after it is dumped on the road surface.

The ordinary method of construction is to build a road like a gravel road, simply dumping and spreading the material, sometimes rolling it, but more frequently leaving the consolidating to be done by traffic. In Maricopa County, however, under H. M. Bargman, County Engineer, a different method of construction is in vogue.

The subgrade is first prepared by scraping off enough of the old material to form small dikes on each shoulder of the road (see Fig. 3). From 4 to 6 in. of caliche is then dumped and spread on the subgrade, using a light 4-mule grader or scraper (Fig. 4) to spread the material. Fig. 5 shows the character of road surface formed.

When a mile or any convenient distance has been prepared with a layer of dry material, water is turned upon the road from an irrigation ditch near its upper end, and the material is "irrigated" from 24 to 48 hr. or longer (Fig. 3). The caliche gradually disintegrates when submerged in water.

The next stage of construction is the floating of the surface, very similar to the floating of concrete, except that a large 8-mule drawn float is used instead of a hand-operated one. Fig. 6 shows the float. It is made of timber with steel-shod wearing edges. It is merely a rectangular frame with a center strut and two diagonal members. It is about 10 ft. wide and is designed to float a longitudinal half of the road at a time. This permits the road surface to be properly shaped with about a 2-in. crown. The floating both compacts the caliche and brings out the lime and dust binder.

When the floating has been thoroughly done, the road is opened to traffic. The surface is not very smooth and resembles a green gravel road. This is gone over after being in use for a time and all the larger stones which have worked out to the surface are raked off (see Fig. 7) to the shoulders of the road. After this, traffic does the rest and eventually a hard smooth surface (Fig. 8) almost resembling concrete is the result.

The enemies of caliche roads, as of gravel roads, are dryness and dusting. In the long dry spells of this part of the country the caliche loses much of its binding material if subjected to fairly frequent automobile traffic, and becomes rutted. It can always be repaired in the same manner as it was originally constructed—by the addition of new material and water. Holes are cleaned out and patched in the same manner.

The possibilities of roads of this type remain to be demonstrated, but there is little question that caliche makes about as fine a natural road surface as can be obtained. If it is eventually proved that such surfaces cannot be economically maintained on the more traveled roads, the caliche forms such an ideal foundation that it is unlikely that such roads will ever require concrete foundations. Brick, asphaltic concrete or any surfacing material could be laid upon a compacted caliche base with results about the same as upon a concrete base.

A portion of the state road from Phœnix to Tempe is of caliche construction, made by spreading and compacting the material dry. State Engineer Lamar Cobb is experimenting on a stretch of this road by covering it with a carpet coat of asphaltic oil and fine gravel. Before applying the oil he has the surface carefully swept free of loose dust and sprinkled with water. So far the results have been quite satisfactory, but it is stated that a thin surface of asphaltic macadam would probably be more lasting.

The cost of constructing caliche roads is not much different from that of gravel roads, ranging probably from $2,000 to $4,000 a mile, depending on the length of haul. The state roads are all constructed by day labor, as is also the county work in Maricopa County.

CALICHE ROAD CONSTRUCTION IN MARICOPA COUNTY, ARIZONA

1—Sharp fragments of stone. 2—Typical caliche bank near Phœnix. 3—Irrigating prepared subgrade. 4—Spreading caliche for surfacing. 5—Character of surface before compacting. 6—Float used in compacting. 7—Intermediate stage of road. 8—Completed caliche road

Heavy Concrete Beams Used in Rebuilding a Theater

By Layton F. Smith*

SYNOPSIS—Interior of old brick hotel torn out to make moving-picture theater. Very long and heavy reinforced-concrete girders required in new framing.

During the past fall and early winter the old Clayton House in Wilmington, Del., was transformed from a nonfireproof hotel to a fireproof moving-picture theater. The lot on which the building stands is approximately 63 ft. wide by 210 ft. long, situated on the north side of 5th St., extending from Market St. on the west to King St. on the east. The grade of 5th St. slopes downward from Market St. to King St., which is very advantageous for theater purposes. The western, or Market St., end of the building is devoted to offices and other business purposes, as is the ground floor on King St., which corresponds to the basement on Market St. The theater portion of the building occupies the central and eastern sections, the stage extending over the shops on King St.

The Market St. end of the building remains with various changes to adapt it to the changed usages as originally built—namely, nonfireproof roof-joist construction—and is separated by a firewall from the theater proper, which has been made by tearing out the old floors and partitions and substituting a system of reinforced-concrete balconies and floors. The original plans for the remodeling of the building called for structural-steel framing not fireproofed, but after several conferences between the contractor, architect and owners it was decided to change the plans so that the structure could be built of reinforced concrete and be absolutely fireproof.

The writer was called in to redesign the structure and found several rather unusual conditions. One was that the roof beams and girders were to be of reinforced concrete to support wooden joists and roof construction. This requirement necessitated one girder 57 ft. center to center of columns, three girders 58 ft. center to center of supporting girders and one that carried the ends of the three 58-ft. girders and additional wooden trusses and had a clear span of 59 ft. All the girders were constructed as T-sections, so as not to require steel in the top for compression. They are seen from below in Fig. 1.

Another adverse condition was that the balcony, the depth of which was governed by the lines of vision of the

*Engineer, 513 North Charles St., Baltimore, Md.

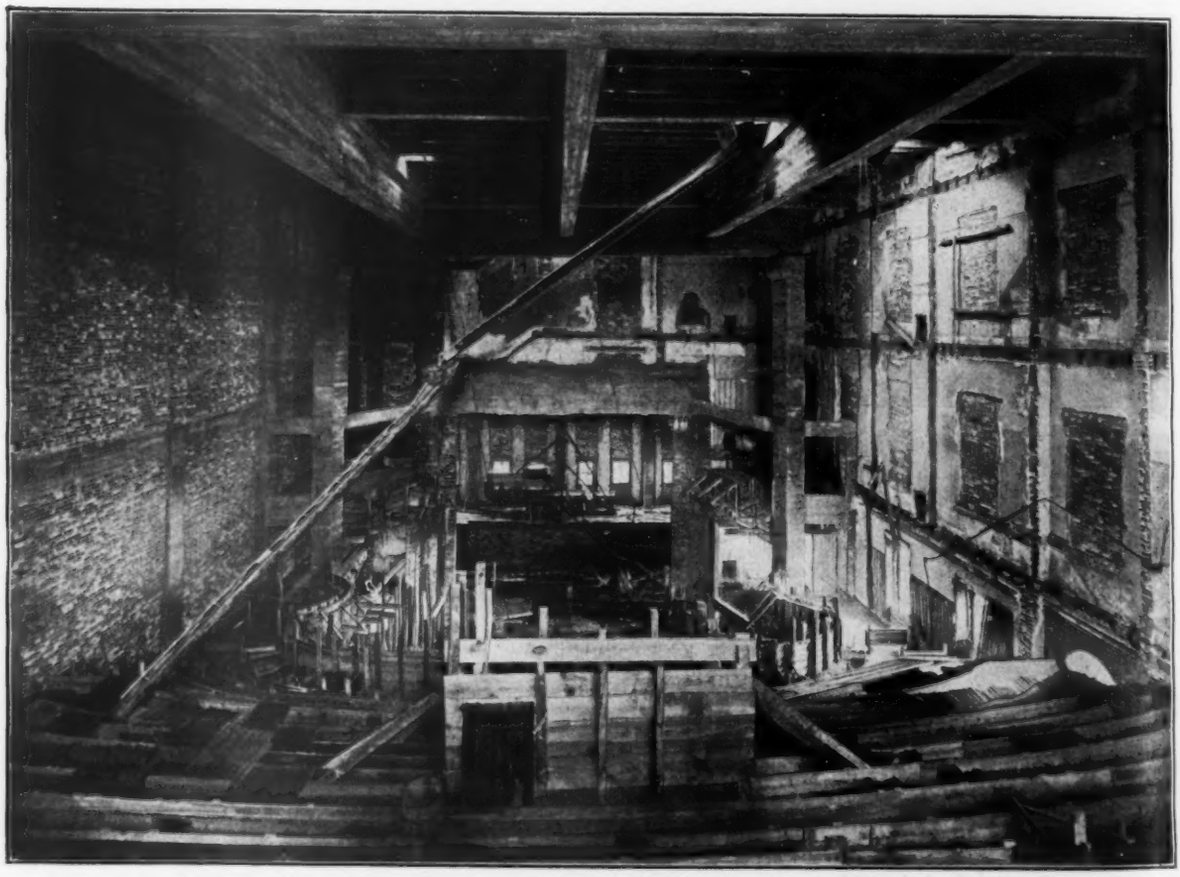


FIG. 1. INTERIOR OF AN OLD HOTEL BEING TRANSFORMED INTO A THEATER
Looking toward stage. Note long roof girders, balcony in foreground and chuting of concrete

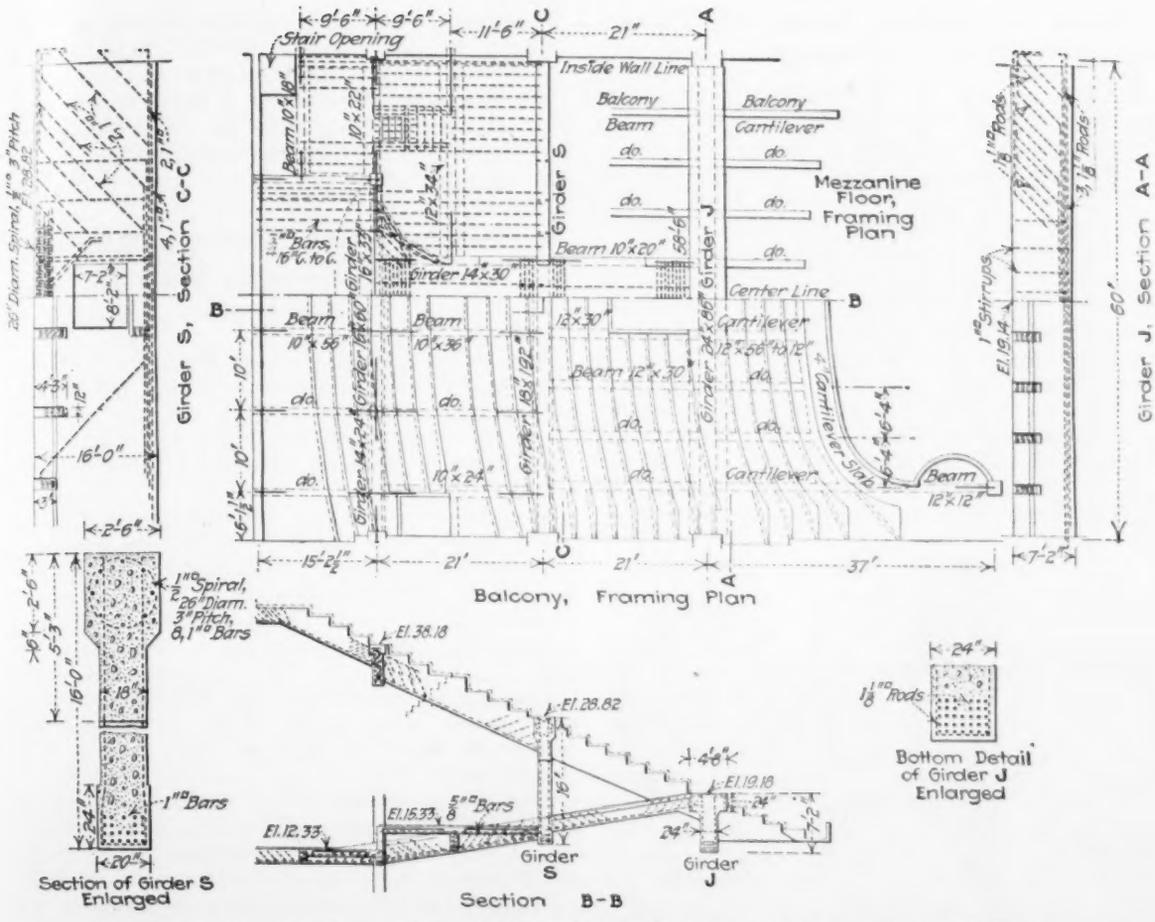


FIG. 2. GENERAL LAYOUT AND DETAILS OF REINFORCED-CONCRETE INTERIOR FRAMING

audience on the ground floor, had to be supported by girders spanning 59 ft. clear between wall columns and spaced 21 ft. center to center. The girder nearest the stage had to be about 13 ft. 6 in. back of the front of the balcony, which was cantilevered for that distance as a minimum. The maximum depth imposed by the line of vision for this fulcrum girder was 7 ft. 2 in.

Probably the most unusual condition was the transverse girder that has to support the sloping gallery on its top and carry a mezzanine floor on one side near its under side. This girder (lettered *S* in Fig. 2) is 16 ft. deep. It has an opening in its center 8 ft. wide by 7 ft. 3 in. high, through which extends a runway giving access to the balcony. On account of the sloping gallery it was impossible to construct this girder as a T-section. Consequently, the upper portion was increased slightly in width to form what might be called a bulb section, and where the opening occurred this bulb section was reinforced with a spirally wound reinforcement that extended well past the sides of the opening. This kick girder is 1 ft. 6 in. thick; and being 16 ft. deep, it forms not only a girder, but also walls for the mezzanine floor.

The method of construction of the interior framing was also unique in that the columns were carried up and the roof girders cast before the balcony was even centered. This procedure was possible because the interior brick walls of the old building were very advantageously located to support the forms and roof girders. Then the roof was covered over and the interior of the building heated, so that the balcony could be poured without danger of frost.

The concrete was chuted into place from a tall wooden tower outside the building, and the entire balcony was poured in one operation lasting about 36 hr. In Fig. 1 the chute may be seen extending through the roof to the balcony under construction. This view also shows the heavy columns supporting the roof beams.

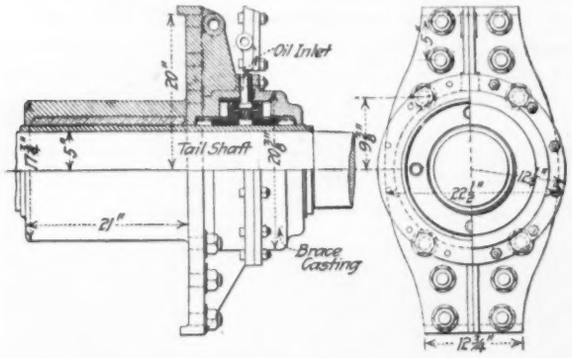
The architect for the building was the Hoffman Co., Philadelphia, Penn. J. A. Bader & Co. were the contractors, and the writer was the consulting and designing engineer.

Edmonton Contracts for Power Supply—The agreement between the Edmonton Power Co., Ltd., and the City of Edmonton, Alberta, covering a period of 21 years has been validated by the Provincial Legislature. The company undertakes to supply the city with electrical power to a minimum amount of 35,000,000 kw.-hr. annually at the rate of 1c. per kw.-hr., the price to decrease on a sliding scale until the consumption reaches 110,000,000 kw.-hr., when it becomes ½c. Negotiations were commenced about three years ago, when a company organized by G. W. Farrell, Montreal (associated with Sir John Jackson, of Sir John Jackson, Ltd., London, England), obtained water rights from the Canadian Government. On Nov. 22, 1915, the citizens of Edmonton voted in favor of the agreement, subject to its ratification by the Legislature. The construction work will be proceeded with and a dam 1,500 ft. wide built on the Saskatchewan River. Sir John Jackson, Ltd., has the contract for the dam and power house. An electric railway to the site of the dam will also be constructed.

Dipper-Dredge Bearing That Wears Slowly

Excessive wear of the outboard bearing has always been a source of trouble in the operation of self-propelled dredges. This wear is produced by the sand, mud, shells, etc., in the overflow, and the nearer an overflow opening is to the stern the greater will be the wear. It has amounted to as much as ⅝ in. in 30 days, necessitating the docking of the ship for repairs within three months of the last repair. This state of affairs and its correction are discussed in a report by W. C. Lemen and Charles G. Bochman, published in the March-April issue of *Professional Memoirs.*

Many attempts were made to improve conditions, but with small success, until a packed self-adjusting bearing was designed. It was applied to the United States dredge "Cumberland" of the Savannah (Ga.) Engineer District in January, 1914. The bearing consisted essentially of two stuffing-boxes faced so as to allow the use of three



WATER-TIGHT STERN-BEARING OF THE UNITED STATES DREDGE "CUMBERLAND"

rings each of ¾-in. square rubber-backed flax packing, as shown in the drawing, which is pressed securely in place by two brass glands, the flanges of which are provided with leather cups similar to those in the flange packing of hydraulic jacks or presses. The glands work in opposite directions and are held against the packing by means of hydraulic pressure produced by an oil pump, when the ship is working. By trial the necessary pressure was found to be approximately 10 lb. The oil is conducted by piping to the space between the glands, the action being similar to pressure put upon two pistons moving away from each other. The tightened packing keeps out sand and grit.

The "Cumberland" underwent a general overhauling in October, 1915, after 20 months' service. The bearing was taken apart and the following conditions were observed:

The square flax packing in the outer stuffing-box had worn considerably itself and had also cut away the steel sleeve shrunk upon the tailshaft, where it came in contact with this packing, apparently due to the grit from the surrounding water entering the stuffing-box and lodging in the soft packing. This abrasion on the shaft and sleeve was most pronounced at the outer turn of packing, less so on the second turn and still less on the third or inner turn, conclusively showing that the sand would have entered the bearing except for the presence of the packing. No sand was found in the chambers between the glands nor in the packing of the inner gland.

The weight supported by this turned bearing is indicated by the fact that the "Cumberland's" shaft is 10 in. in diameter and swings a cast-iron propeller of 11-ft. diameter and 11½-ft. pitch, weighing 6,600 lb., the rotation being 107 r.p.m. After one year's successful use of the bearing on the "Cumberland" it was deemed advisable to install similar bearings upon the dredge "Savannah," a twin-screw ship whose bearings had given much trouble from rapid wear.

Reinsch-Wurl Sewage Screen, Long Beach, Calif.

By E. A. Rowe*

The sewage-disposal plant at Long Beach, Calif., recently completed in connection with a new sewer system, has two unique features: (1) It is the first plant to be put in service in this country in which a Reinsch-Wurl screen is employed, and (2) the screenings are burned at the works.

The plant is located in a reinforced-concrete building on the beach, about 400 ft. back from the ocean and approximately 10 ft. above high water. It is designed to serve an ultimate population of 50,000, based on an average daily flow of 75 gal. per capita.

The sewage first passes through a coarse bar screen (Fig. 2), from which the matter retained is raked into a trough at the top of the screen and dumped into a receiving can. After passing the bar screen the sewage flows to the Reinsch-Wurl screen, which revolves about an axis at an angle of approximately 20° from the vertical, the lower edge of the disk dipping into the sewage. This screen is made up of a number of perforated plates; and as the sewage flows against it, the liquid passes through the perforations, while the solids are deposited on the surface and are carried out of the liquid by the rotation of the screen and removed from the screen by brushes, as described later. The screened sewage passes to a sump, from which it either flows or is pumped into the ocean, depending upon the stage of the tide. The sludge is burned in an incinerator.

Description of Reinsch-Wurl Screen

The main screen consists of a circular disk about 20 ft. in diameter with plates in the shape of a frustum of a cone mounted about its axis. The entire surface is made up of plates of manganese bronze about $\frac{1}{16}$ in. thick, perforated by slits $\frac{1}{32}$ in. in width by 2 in. long. These

*Engineering offices of J. B. Lippincott, Los Angeles, Calif.

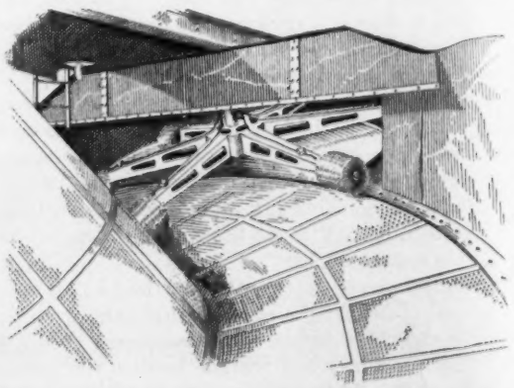


FIG. 1. REINSCH-WURL SEWAGE SCREEN, LONG BEACH, CALIF.

slits are ¼ in. c. to c. and are enlarged on the under side. The perforations are cut so that the brushes in passing over the surface tend to clean them. The screen is mounted on a steel spider hung from a large bearing at the top. In order to prevent the solids from flowing through the joint at the outer edge of the screen, steel plates carefully cut and mounted have been placed on the outer frame to seal the joint as tightly as possible. The screen is revolved by means of a rack on its under edge, driven by a pinion on the shaft carrying the brushes.

The screenings are removed by means of revolving brushes (Fig. 2) mounted on a revolving steel spider. While the spider is carrying the brushes over the screen, they are revolving in a direction opposite to the movement of the screen. The brushes are geared in such a manner as to exert no pressure upon the screen other than their own weight and to adjust themselves to any unevenness in the screen. The brushes roll the solids ahead of them, at the same time cleaning the slots in the screen. The screen plates on the conical part are cleaned by similar brushes. The screenings swept from the plates are rolled into a trough that discharges into receiving cans. The screens and brushes are driven by a 2½-hp. motor. The screen makes ½ r.p.m. and the brushes 4 r.p.m.

The receiving cans rest on a turntable that is operated by a handwheel on the main floor, so that empty cans can be placed under the trough by turning the wheel.

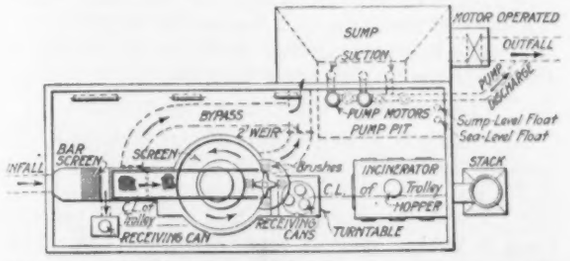


FIG. 2. PLAN OF SEWAGE WORKS, LONG BEACH, CALIF.

An overhead trolley system, equipped with a chain hoist, is provided for raising the cans to the incinerator used for burning the sludge. A record is kept of the time at which each can is filled and the net weight of the sludge collected.

Screenings Are Burned in Incinerator

The incinerator is equipped with two sets of Johnson oil burners and is designed to consume 150 cu.ft. of sludge in 8 hr., using 5 gal. of fuel oil per cubic foot of sludge consumed. The sludge is dumped into the furnace from the top about 3 hr. before the fires are started. It first rests on the upper drying hearth, located in front of the oil burners, which is built up of fire-clay brick with narrow openings between them to allow the liquids to drain to the bottom of the furnace. This liquid comes from the moisture content of the sludge, which with this system is approximately 80%. After a temperature of 2,200° F. is reached in this chamber, the top of the pile is soon reduced to an ash and from time to time is poked down on the lower hearth until the upper hearth is clean, when the fires are extinguished. The lower drying hearth is made of solid firebrick. It is parallel to the upper hearth and about 2½ ft. below it. The flames pass over the upper hearth and to the rear of the furnace, then down and over the lower hearth to the front of the furnace. The temperature on the lower hearth is approximately 1,600° F. The ash is spread over this hearth and allowed to remain here until it is removed. Below the lower hearth the bottom of the furnace is made to receive all the liquid that passes

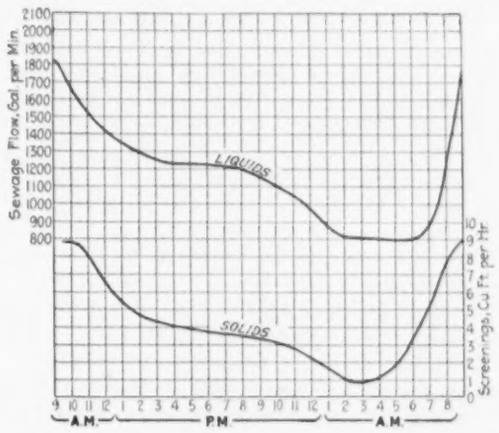


FIG. 3. SEWAGE TREATED AND SLUDGE REMOVED BY WURL SCREEN, LONG BEACH, CALIF.

down from the upper hearth and is here evaporated. The flames after passing over the lower hearth go down and over the top of the evaporating pan to the rear of the furnace and up to the stack through a series of staggered baffles placed so as to retain all the heat possible in the furnace. The temperature at the baffles is about 800° F. After the fires are extinguished, the ash is allowed to remain on the lower hearth for about 3 hr. before it is removed.

The liquid effluent after passing the screen flows through the outfall channel into the sump. A weir is located in this channel for measuring the discharge. It is equipped with a recording register, and from this record and the records of solids collected the accompanying diagram (Fig. 3) has been prepared. As the plant is not high enough to permit the screened sewage to flow into the sea by gravity at all times, a system of automatic switches has been installed, operated by floats. An automatic tide gate has been placed in the outfall so that, when the tide reaches such a level that the liquid will not flow from the sump, the gate closes and the pumps start. There are two of these pumps, automatically run so as to keep the liquid in the sump at a specified level at all times. The outfall sewer is of 36-in. cast-iron pipe, resting on a pile cradle, and extends about 800 ft. into the Pacific Ocean.

The plant was installed by the Sanitation Corporation, New York City, under the engineering direction of Olmsted & Gillelan, Los Angeles, Calif.

A Uniform Municipal-Accounting System has been worked out by the Wisconsin Tax Commission, under statutory authorization. The system has already been adopted by 18 municipalities, including Ashland, Eau Claire, Green Bay, Madison and Ripon. The Municipal Reference Bureau, University Extension Division, Madison, Wis., is prepared to lend to city officials of Wisconsin, material illustrating uniform accounting systems and showing their value. The division states that uniform municipal accounting systems have been worked out in New York, Ohio, Massachusetts, Indiana, Iowa, Washington and Wisconsin. The adoption of the uniform system is compulsory in Ohio.

Excavation for the Baldwin Reservoir, Cleveland

A large earth- and rock-moving job is under way in Cleveland in the excavation for the 130,000,000-gal. Baldwin low-service reservoir. The existing low-service reservoir, known as Fairmount, was built in 1885 and for some years has been regarded as inadequate, for 80% of the total water required for the city is now consumed in the low-service district. The capacity of the old Fairmount reservoir is 80,500,000 gal., and the daily consumption in the district is 64,000,000 gal.

In 1908 thirty acres of land extending from Baldwin Road to East Boulevard was purchased for additional reservoir purposes. In the winter of 1914-15 some work (top-soil removal) was done on the reservoir by direct labor, the sole purpose of which was to provide work for the unemployed at that time. Bids were received for the excavation on Apr. 2, 1915, under specifications which required that the contractor dispose of all the excavated material, the city allowing dumping in a near-by abandoned quarry that would hold about 300,000 yd., one-half of the total excavation.

The plans called for an excavated basin 1,035 ft. long by 576 ft. wide, with an average depth of 33 ft. The total quantity of material to be removed is 746,000 cu.yd., consisting of yellow clay, blue and black shale and bluestone. The greater part of the stone is at the east end of the basin and amounts roughly to 200,000 cu.yd.

Preliminary Investigations of Site

In recognition of the need of knowing as much as possible about the subsurface conditions at the site the city had a number of test holes sunk previous to advertising for bids and incorporated the information so obtained in the bidders' drawings (see Fig. 3). This information, unfortunately, was not altogether satisfactory, for the reason that but two of the holes went down as open pits to the depth of excavation. The holes below the open pit were made with rock drills, and the results were uneven on account of the seamy character of the rock. The heavy bluestone at the south end of the excavation was not tested by open pits, and mud brought up by the rock drills would not differ materially whether shale or bluestone was encountered. Inasmuch as the cost of excavation might be considerably influenced by the character of the material, H. P. Hammer, Assistant Engineer of Construction, Division of Water of the city, made studies of mud from the drill, in the hope of being able to determine the character of the rock from these drillings, but the results were not of a positive nature. One clause of the specifications was therefore made to read as follows:

> **The contractor must assume the risk as to the nature of the ground or kind of material to be excavated, as the city does not guarantee the indications of the borings to be correct. The contractor shall not receive any extra payment and shall have no claim for damages in case the material actually encountered in the execution of the work differs from that indicated by the test borings.**

Some of the contractors bidding on the work were not satisfied with the conditions as shown and made their own more or less exhaustive examinations of the site. One of them, the Fred R. Jones Co., Cleveland, made a very careful analysis of the whole situation, not only in regard to the subsurface conditions, but also in examination of the methods of spoil disposal. Whether this work, which it is stated occupied two weeks of the time of the company's engineers, was the cause or not, the Jones company was awarded the contract on the low bid of $235,505, the other nine bids ranging from $272,764 to $738,150, the average of the ten bids being $433,900.

Contractor's Plant and the Blasting

The contractor's equipment is of very high grade. The running tracks—layout of which is shown in Fig. 2—are of 75- and 80-lb. rails on hardwood ties and cinder ballast. The shovel shown at work in one of the views is a Class B 120-ton Bucyrus equipped with a 4-yd. dipper. A lighter shovel was used to remove the top soil. The spoil is moved in 30-yd. automatic all-steel Western air-dump cars. In the beginning 12-yd. wooden cars were used, but the rock damaged them considerably. Even these steel cars do not escape injury; the sideboards are

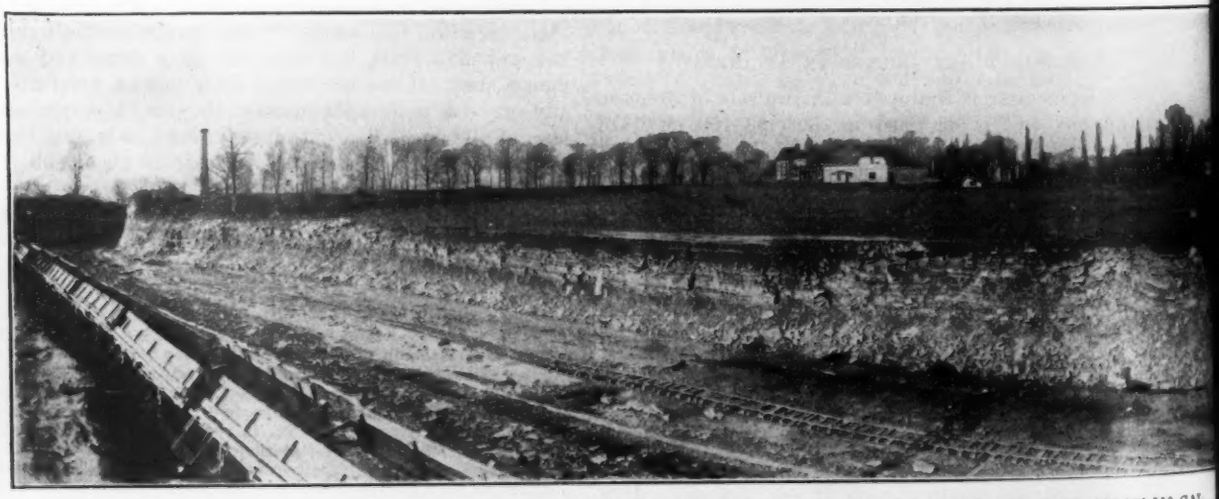


FIG. 1. ROCK-EXCAVATION WORK IN PROGRESS FOR THE 130,000,000-GAL.

Left half of panorama shows the rock strata at the southwest front of the site. The rock is hard and tests have shown it to be suitable for concrete aggregate; it will be so employed in the concrete lining of the reservoir

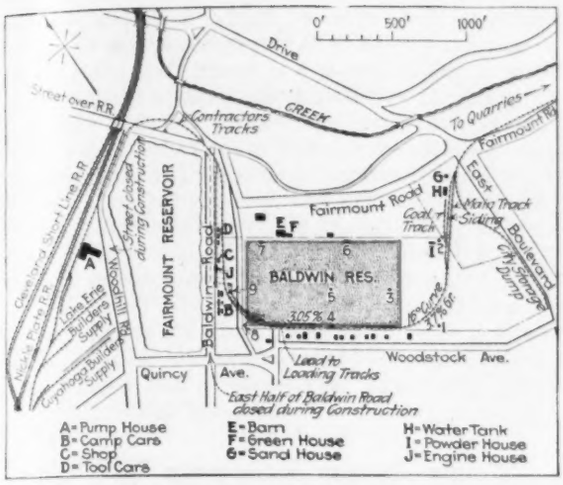


FIG. 2. CONTRACTOR'S TRACK LAYOUT AT BALDWIN RESERVOIR, CLEVELAND

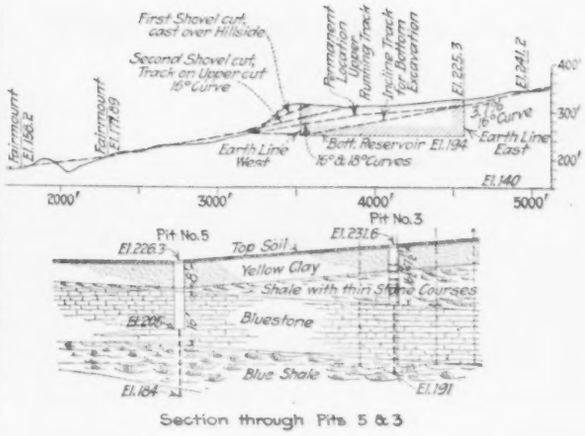


FIG. 3. CHARACTER OF SOIL AS INDICATED BY THE TEST PITS

cut by stones dropping from the dipper and by rocks (hanging out of the bottom of the dipper) being dragged over the sideboards. To get the cars out of the hole and where the grade exceeds 4.37% three locomotives are required to handle five of the 30-yd. cars—one pushing and two pulling. Pennsylvania R.R. switch engines are used. The weight of each is 50 tons on the drivers; the cylinders are 19x24 in.

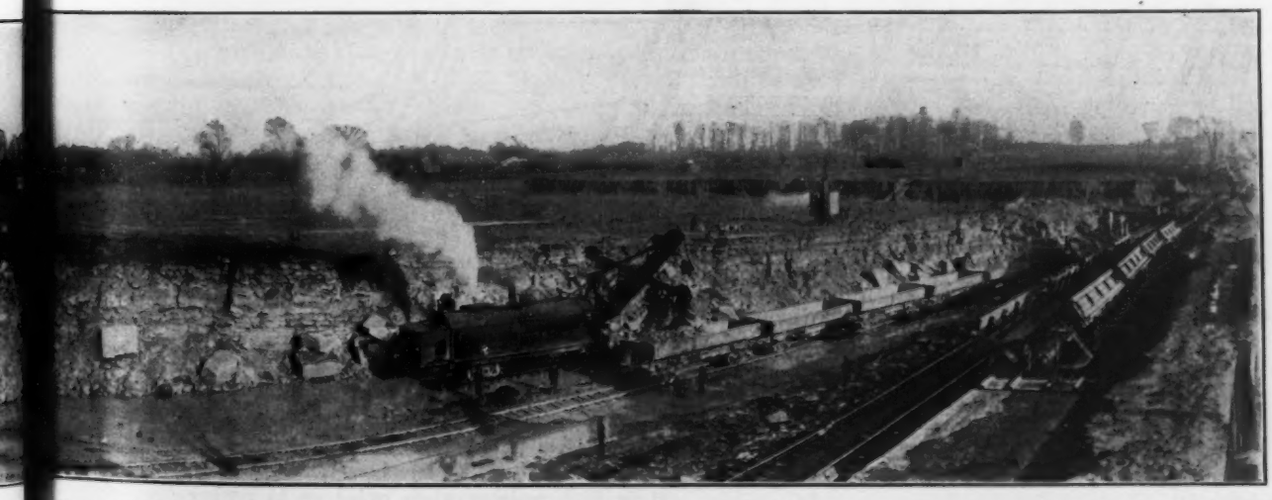
As shown by the large view, the top soil was first removed over the entire site. Rock excavation was started on the southwest side. The first cut ran the full length of the site, and the excavation proceeded northwest in parallel cuts.

The track plan shows a row of houses on the side of the reservoir where the excavation was started. Drilling and shooting were of course necessary, and great care had to be exercised in the beginning. Until the excavation reached the bottom, drainage could not be installed and the blasting holes were full of water. After the drainage system was put in, the holes were dry, and black powder could be used. The wet holes required the use of dynamite, about two cases being used in each wet hole.

Mr. Jones speaks highly of the Ingersoll-Rand turntable wagon drill, which he uses to put down the blasting holes. The machine is moved along on a track of 6-ft. 3-in. gage and drills a 3-in. hole down to 50 ft., striking 120 blows per minute. Mr. Jones says he can put down 250 ft. of hole in 10 hr. Previously to acquiring this outfit a well-drill was used.

At the present time the method of shooting is as follows: Three-inch holes are driven on about 18-ft. centers. The hole is chambered out with 16 sticks of dynamite and is then loaded with from 4 to 6 kegs of black powder. Two rows are shot ahead of the shovel, but the shovel-boom does not reach the full width of the shot. The spoil is loaded on the dump-cars, which proceed to the quarries provided by the city. The stone encountered at the south end of the cut, however, is quite suitable for concrete aggregate and is being stored by the contractor in the expectation of its being used for the concrete work to be done on the reservoir proper.

Work started May 1, 1915, to the extent of general preparation such as laying tracks. Excavation was begun on May 24. The contractor expects to finish by next July.



LOW-SERVICE BALDWIN RESERVOIR IN CLEVELAND, OHIO

This half of panorama shows the excavating and handling plant at work. Track at right is for storage of empties; loaded trains pass out on middle track; shovel loads for left-hand track, as illustrated

Engineers in Public Affairs*

By Charles R. Gow†

Much has been said in recent times concerning the desirability of engineers and engineering societies participating individually or collectively in attempts to influence or direct public affairs.

There probably never was a time in the history of our nation when there was greater need than at present for a wise and judicious oversight of the detailed actions of our governmental representatives; but the need which exists is for constructive assistance rather than for destructive criticism. There is already a great surplus of voluntary advisers who apparently seek to usurp the administrative functions of our several appointive and elective officials, leaving to those parties only the responsibility for such failures as may ensue. This I contend is an interference with good government and not an assistance. The need rather is for responsible bodies in the several communities, composed of individuals who from their nature and position command the confidence and respect of a majority of good citizens, who will analyze in a purely scientific, impartial and dispassionate manner such public acts and contemplated actions as they may by knowledge and experience be qualified to pass judgment upon and will render their decisions in accordance with the actual facts, ascertained only after an exhaustive consideration of all the evidence available, regardless of prevailing prejudice, personal effect or political consideration; who will strongly defend public officials against irresponsible criticism whenever they are found to be right, even though such officials may otherwise be lacking in popular favor; who are capable of looking on matters with a broad perspective and who are willing even to suffer personal loss if the contemplated act is for the good of the greater number of people.

I must confess that this outline of requisites presupposes an ideality not usually realized in present-day activities; but I will contend that if such attributes exist in the membership of any organization they may be expected to prevail among those composed of engineers. It is possible, therefore, that such a field of usefulness may be open to our society, but such a departure should, in my opinion, be made with extreme caution.

When we have arrived at a position which warrants assurance that a majority of our members are constituted mentally and morally so as to guarantee immunity from the danger of personal bias or attempted individual aggrandizement; when we display a disposition always to accord full credit to its proper source, even when by so doing it may be necessary to reward those whom personally we dislike; when we appear disposed to sink our own interests and welfare into obscurity and stand for a given principle at a personal sacrifice; and when we are able to brush aside all outward impressions of an indefinite and inconclusive character and form our judgment upon ascertained facts only—then may we feel justified in interfering with administrative matters of a public or semi-public nature for the benefit of the community at large.

In the meantime there is much useful work of a public character to which we may, if we wish, contribute. Our membership should be made available at all times to such public officials and commissions as may require expert opinions or scientific determination of facts.

*From the address of the retiring president of the Boston Society of Civil Engineers. The complete address is given in the April "Journal" of the society.

†Civil Engineer and Contractor, West Roxbury, Mass.

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Four-Span Railway Bridge Rolled Into Place

Bridge 160 on the Fitchburg division of the Boston & Maine R.R., which has recently been replaced, spans the Deerfield River at a point 0.2 mi. west of Bardwell station. The approaches to the bridge are on a 5° 51′ curve at the east end and 4° 23′ on the west end, and these curves, with easements, extend onto the bridge 147 and 188 ft. respectively, leaving 250 ft. of tangent at the center of the bridge.

The old double-track deck bridge, 585 ft. long, composed of six spans—three of pin-connected trusses and three of plate girders—was replaced by three spans of riveted trusses and three spans of plate girders designed for a modified E-60 loading.

The principal feature of this replacement was the contractor's method of erection, which allowed the least interruption to traffic. Owing to the sharp curvature of the approaches and the lack of space on the right-of-way for assembling, it was considered more advisable to place falsework in the river and erect the new trusses along the downstream side of the old bridge. In the main the falsework was in the form of pier extensions (Figs. 3 and 4), the downstream sections to carry the trusses during erection and the upstream sections to carry the old bridge when it was rolled out and scrapped.

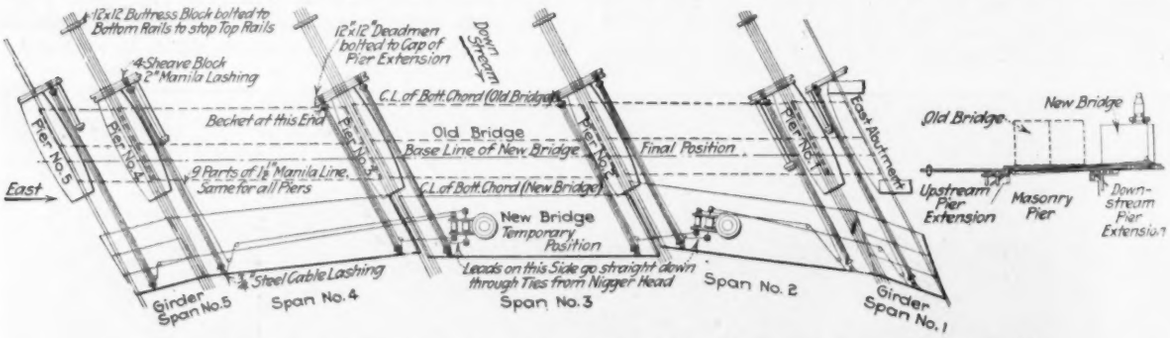


FIG. 1. METHOD OF RIGGING FOR ROLLING IN NEW BRIDGE AND ROLLING OUT OLD

Three spans of the new trusses and two spans of the plate girders were erected, with bearing points on rolls and so lined that the members were exactly parallel to their final position when rolled in to replace the old bridge. After the erection was completed, the old bridge was jacked up and the same rolls extended under it.

Hoisting engines and lines were then placed as shown in the diagram in Fig. 1.

On Mar. 6, 1916, the five new spans were rolled in, the actual time consumed in rolling being 6 min. The tracks were broken for a period of 5 hr., with no delay to passenger trains. This time allowed for the throwing of the tracks on the approaches from 12-ft. to 13-ft. centers, blocking up back of parapets to allow for masonry changes, relining tracks on the westerly span and connecting the tracks on the approaches with the tracks previously placed on the bridge. The sixth, or westerly, span was placed by car derrick on Mar. 26.

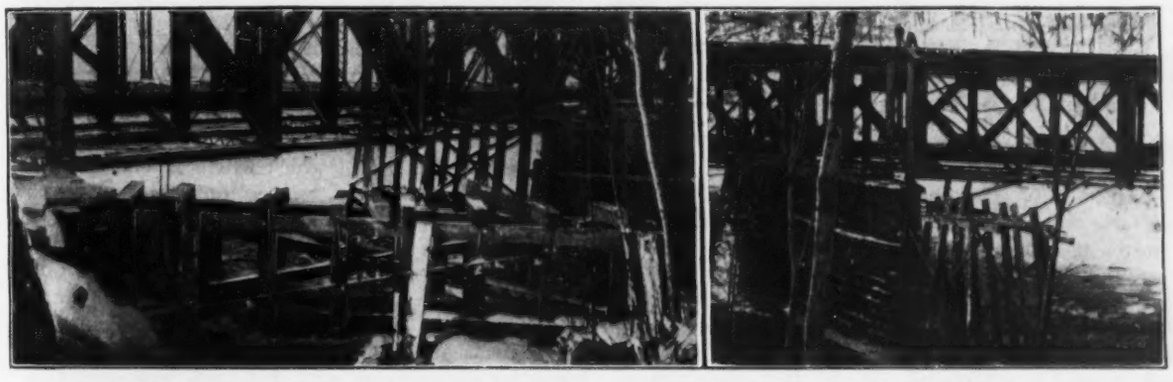
FIG. 2. BRIDGE 160 ON BOSTON & MAINE R.R. ON FEB. 14, 1916; UPSTREAM FALSEWORK AT PIERS 4 AND 5

The entire work was under the direction of A. B. Corthell, Chief Engineer. The designing was by B. W. Guppy, Engineer of Structures; and supervision of erection was by G. L. Huckins, Construction Engineer, and H. L. Farwell, Resident Engineer. The American Bridge Co., of New York City, was the contractor; H. G. Reynolds, Superintendent of Erection.

TIME SCHEDULE

Pier extensions for erection.....	Oct. 6 to Nov. 8, 1915
Steel erection, 1,200 tons.....	Nov. 10 to Dec. 11, 1915
Riveting, 42,648 rivets.....	Dec. 12 to Feb. 8, 1916
Deck work, 103,000 ft. b.m.....	Jan. 20 to Jan. 29, 1916
Average number of men per day....	40

Between Nov. 15, 1915, and Mar. 16, 1916, twenty-six working days were lost on account of bad weather. Lost efficiency of crew amounted to 40% on account of bad weather.



FIGS. 3 AND 4. LEFT—UPSTREAM EXTENSION TO PIER 1. RIGHT—UPSTREAM EXTENSION TO PIER 2

Land Drainage in Michigan

The soil in the southern peninsula of Michigan ranges from sand to heavy clay and peat and its elevation, from water level to an altitude of 400 to 600 ft. Some few large ditches have been dug by floating dredges, but the greater part of the drainage work consists of small independent ditches and tile drains. These are made mostly by hand, but also by teams and scrapers and more recently by dry-land dredges. Larger drainage matters are beginning to receive attention, and the outlook for such work is favorable.

While a portion of the land will always be occupied by lakes and streams, many of the small lakes are little more than marshes and can be entirely or mostly reclaimed. Adjacent to the lakes are marshes, peat or muck bogs, or swamps, frequently productive when reclaimed. The natural drainage of the country has been impaired by the construction of dams for power purposes and by the consequent silting of the streams and rise of the general groundwater table. This has made impossible the adequate tile drainage of a great many farms and has led to the construction of many miles of shallow drains which, while costing nearly as much as through drainage, accomplished but little good.

The Michigan law requires that a record of each drain shall be kept by the drain commissioner and that each year all the original papers of completed drains shall be filed with the county clerk. There seems to be little uniformity in the office methods, but in one county the arrangement is so good as to call for mention. The drainage office has two large rooms in the courthouse, with a large fireproof vault. The office force, besides the commissioner, consists of a deputy drain commissioner and an engineer, on a monthly salary. The latter devotes part of his time to county highway work, for which he receives extra compensation. Extra help is employed as needed for the serving and posting of notices, recording, etc. The commissioner makes constant use of his automobile, for which a nominal mileage charge is made.

The drainage record is composed of loose-leaf volumes, in order that the record may be typewritten. An alphabetical index of all drains is kept in separate books, and also an index arranged first by townships and then alphabetically, in order to facilitate the finding of a drain record whose location is known, but name forgotten.

Rapid Transit Work in 1915, New York City

By D. A. Sealey, Assistant Engineer, Public Service Commission, New York

With an introduction by Robert Ridgway, Engineer of Subway Construction, New York Public Service Commission

Introduction—A comprehensive series of articles by F. Lavis on the new rapid-transit system of New York City was published in *Engineering News* between Oct. 1 and Dec. 31, 1914. This system is generally known as the "Dual System" from the fact that it is to be operated by two companies—the Interborough Rapid Transit Co. and the New York Consolidated Railroad Co., assignee of the New York Municipal Railway Corporation—for a term of 49 years under contracts made with the city acting by the Public Service Commission for the First District, on Mar. 19, 1913. Since Mr. Lavis' articles were prepared, the construction work has advanced rapidly and at the end of 1915 was a little over 50% completed.

A paper read before the Municipal Engineers of the City of New York by LeRoy T. Harkness, Assistant Counsel, Public Service Commission, entitled "The Dual System Contracts in Their Relation to the Rapid-Transit History of New York City," published in the 1913 "Proceedings" of that society, gives a very clear and interesting description of the features of the Dual Contracts under which the new system is being constructed and will be operated. The article by Mr. Sealey which follows describes briefly some of the features of construction and states what progress has been made.

The question is frequently asked why the contracts for construction were so arranged that several miles of trunk subways in Manhattan, along Broadway and Lexington Ave., and in the Bronx were completed a year in advance of the time when the remaining sections can be completed and put in operation. The answer is that these sections were intended to form part of the so-called "Triborough" route originally designed for an independent system of operation, and the contracts for their construction were let in 1911 and 1912, whereas the Dual Contracts date from 1913. In the latter contracts provision is made for incorporating in the respective operating systems the Triborough sections then under construction, as well as the completed Center St. loop in Manhattan and the then nearly completed Fourth Ave. subway in Brooklyn.

Mr. Lavis compared the cost of it with that of the Panama Canal, which was $375,000,000. As of interest in this connection the table on this page shows by years from 1907 to 1915 inclusive the gross amounts estimated on account of the construction of the city-owned lines, including both the city's and each company's share. In addition, a large amount has been spent by both companies in third-tracking and extending the company-owned elevated lines.—Robert Ridgway.

Rapid-transit construction in New York City has progressed steadily since the signing of the Dual System contracts Mar. 19, 1913. The Dual System project involves the construction of new elevated and subway lines and the reconstruction and extension of existing elevated and subway lines. In general, the Interborough company will operate all the lines in the Borough of the Bronx and lines throughout the length of Manhattan, with elevated lines extending into the Borough of Queens and certain elevated and subway lines extending into the Borough of Brooklyn, while the Municipal company will operate most of the elevated and subway lines in the Borough of Brooklyn, with sufficient subway lines entering Manhattan to distribute passengers.

The two maps, Figs. 1 and 2 (reproduced from *Engineering News* of Oct. 1, 1914), define the new lines and show the complete rapid-transit network. On completion the system will have treble the capacity of the existing lines. The estimated total cost of the new system, including construction and equipment, approximates $350,000,000, of which the Interborough will contribute about $105,000,000, the Municipal company about $61,000,000 and the city about $184,000,000. The city has already invested about $56,000,000 in the construction of the present subway and the Interborough Rapid Transit Co. about $48,000,000 in equipment on this line, representing about $104,000,000 which is not included in the above estimated cost; the cost of the existing elevated railways is also not included.

The new system, including existing and proposed elevated and subway lines, will comprise about 620 mi. of single track, 360 mi. of which will be operated by the Interborough and 260 mi. by the Municipal company.

At the close of the year 1915, out of the total of 89 contract sections of the city-owned lines the Public Service Commission had awarded 73 contracts of value $167,606,989.70. It is expected that the remaining 16 contracts will be awarded during the present year. The 26 contracts awarded in 1915, together with other contracts for station-finish work and track, aggregate $26,096,639. In addition, the value of work either completed or under construction on third-tracking and extensions of elevated railroads by the companies at the close of the year 1915 amounted to $25,000,000.

TABLE OF EXPENDITURES ON CITY-OWNED LINES OF NEW RAPID-TRANSIT SYSTEM, NEW YORK CITY

(Amounts given include both city and company share of cost. Third-tracking and extensions of company-owned lines are not included.)

	I. R. T. Co., Contract 3	N. Y. M. Ry. Corp., Contract 4	Total
To Dec. 31, 1907*	.....	$975,364	$975,364
To Dec. 31, 1908*	.....	4,602,877	4,602,877
To Dec. 31, 1909*	.....	7,327,769	7,327,769
To Dec. 31, 1910*	.....	12,500,707	12,500,707
To Dec. 31, 1911*	$275,340	20,219,446	20,494,786
To Dec. 31, 1912*	6,041,544	25,539,169	31,580,713
To Dec. 31, 1913*	16,293,199	31,468,958	47,762,157
To Dec. 31, 1914	33,219,215	42,590,207	75,809,422
To Dec. 31, 1915	54,635,206	54,925,299	109,560,505
City's share	$35,752,557	$50,576,458	$86,329,015
Companys' share	18,882,649	4,348,841	23,231,490
Total to Dec. 31, 1915	$54,635,206	$54,925,299	$109,560,505

*The figures for the years prior to 1913 and part of the 1913 expenditure represent construction of the Center St. loop in Manhattan, the Fourth Ave. subway in Brooklyn and the Broadway-Lexington Ave., or Triborough, subway in Manhattan and the Bronx—two Bronx sections besides the Harlem River tunnel and the Lexington Ave. section being under contract. These construction expenditures were taken over into the Dual Contracts arrangements.

The total value of construction completed as of Dec. 31, 1915, was $109,560,505.

The average daily force of the contractors on all of the work under the Dual System, including company and city contracts, is at present about 15,000 men. This force has been larger in the past, reaching a maximum of over 20,000 men. There are at present about 1,500 engineers of all grades on the commission's payroll, and the cost of engineering for the past year amounted to $3,000,000.

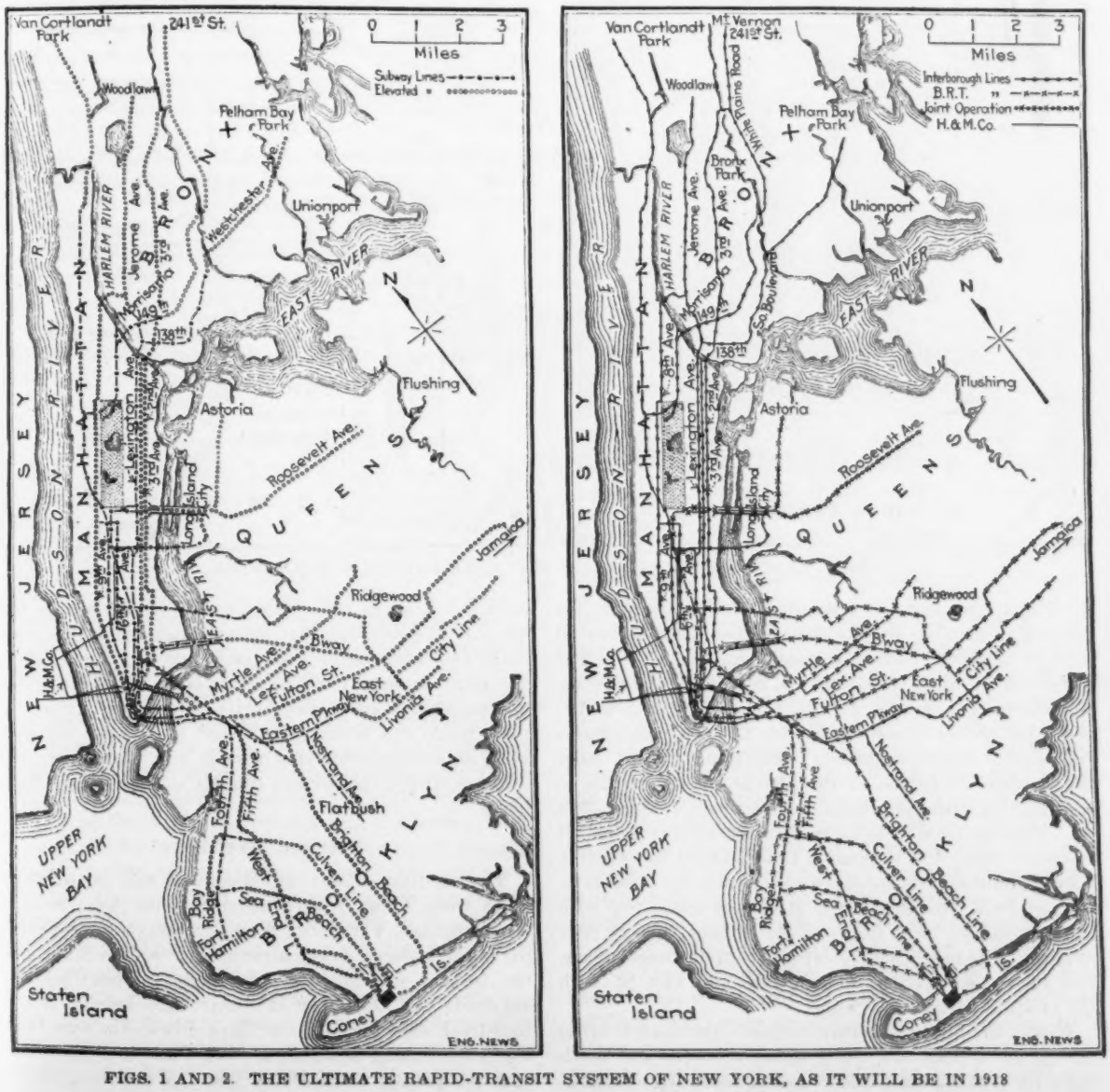
The scope of this article will not permit a description in detail of construction progress since the signing of the Dual System contracts. The statements below will therefore be confined to the past year.

Interborough Lines—Lexington Ave. Line

The existing subway in Manhattan is extended north from 38th St. and Park Ave. as a four-track subway, curving under private property where the Grand Union Hotel formerly stood, thence under 42nd St. to Lexington Ave., by way of Lexington Ave. and the new Harlem River tunnel into Bronx Borough and by way of Mott Ave. and Girard Ave. as far as 157th St., whence the line continues north as a three-track elevated structure for a distance of about 5 mi. along Jerome Ave. as far as Woodlawn Road near the city line. At 135th St. a line branches to the east as a three-track subway under 138th St. and to Pelham Bay Park, a distance of about 6¾ mi.

The entire Lexington Ave. line north of 53rd St. is now nearing completion, including the westerly branch into the Bronx and the easterly branch as far as Whitlock and Westchester Ave. Work on the elevated structure along Westchester Ave. from Whitlock Ave. to Pelham Bay Park will shortly begin. This work comprises a new section, bids on which were opened Nov. 30, 1915 (the contract has since been awarded).

Work on the section from 43rd St. to 53rd St. was begun in August, 1914, and is now over 45% completed. North of 46th St. this section is a double-deck structure with the two express tracks below and the two local tracks above, an arrangement typical of the greater part of the Lexington Ave. line. South of 46th St. the local tracks diverge so as to permit the express tracks to come up be-



FIGS. 1 AND 2. THE ULTIMATE RAPID-TRANSIT SYSTEM OF NEW YORK, AS IT WILL BE IN 1918

tween them, all tracks reaching the same grade at about 44th St., approaching the station south of this point.

The contract section for the connection with the present subway extends from 38th St. north along Park Ave. to 41st St., thence curving northeasterly under the site of the old Grand Union Hotel and 42nd St. to Lexington Ave., the hotel having been razed in connection with subway construction.

The Diagonal Station

A station extends diagonally across the old Grand Union site and 42nd St. and consists of two island platforms with the express tracks between and the local tracks outside of them. On account of its diagonal position with respect to the rectangular streets, it has been popularly called Diagonal station. The construction of this section is of unusual interest, particularly the work south of Diagonal station, on account of its proximity to the present subway as well as the street-car tunnel located directly above the subway tunnels in Park Ave. The latter consist, south of 41st St., of two separate two-track tunnels, built sufficiently far apart to permit the construction of a tunnel between them for the two new express tracks from Diagonal station. This tunnel passes under the northbound tunnel of the present subway, rising to a connection with the present express tracks at about 39th St. The southbound local track after leaving Diagonal station is carried in a separate tunnel under the existing subway tunnels, continuing south under the west sidewalk of Park Ave. on a rising grade to a connection with the southbound local track of the present subway near 38th St. The northbound local track enters Diagonal station from a connection between 40th and 41st St. with the existing northbound tunnel.

Within the limits of private property the work is being carried on in open cut, while under 42nd St. and north the work is being done under decked roadways. Excavation for the tunnels from Diagonal station was carried from the site of the hotel (Fig. 5). A shaft was also sunk within the park space on Park Ave. south of 40th St. to the subgrade of the new express tunnel and excavation carried north and south from this shaft. The excavation is in rock in the tunnel portions and in earth and rock in the open-cut portions. The material is hauled to the Grand Union site by mules, raised by electric derricks to the street level and removed by horse trucks. The excavated material is disposed of similarly through the 40th St. shaft. The contract time for completion of this work is 28 months, and the contract bid price (including a portion of the Steinway tunnel extension) is $3,097,312.50. Work was started in December, 1914, and is now over 47% completed.

Considerable care in the prosecution of this work is required so as not to interfere with traffic in the present subway. A slight conception of the problem can be had when it is considered that express trains pass this point every 1½ min. during rush hours and local trains every 2½ min. It should also be remembered that over 1,000,000 passengers are carried in the subway daily. No express trains run between 1:30 and 5:30 a.m., and such work as setting protecting shields and permanent steel columns within the present tunnels is done during these hours.

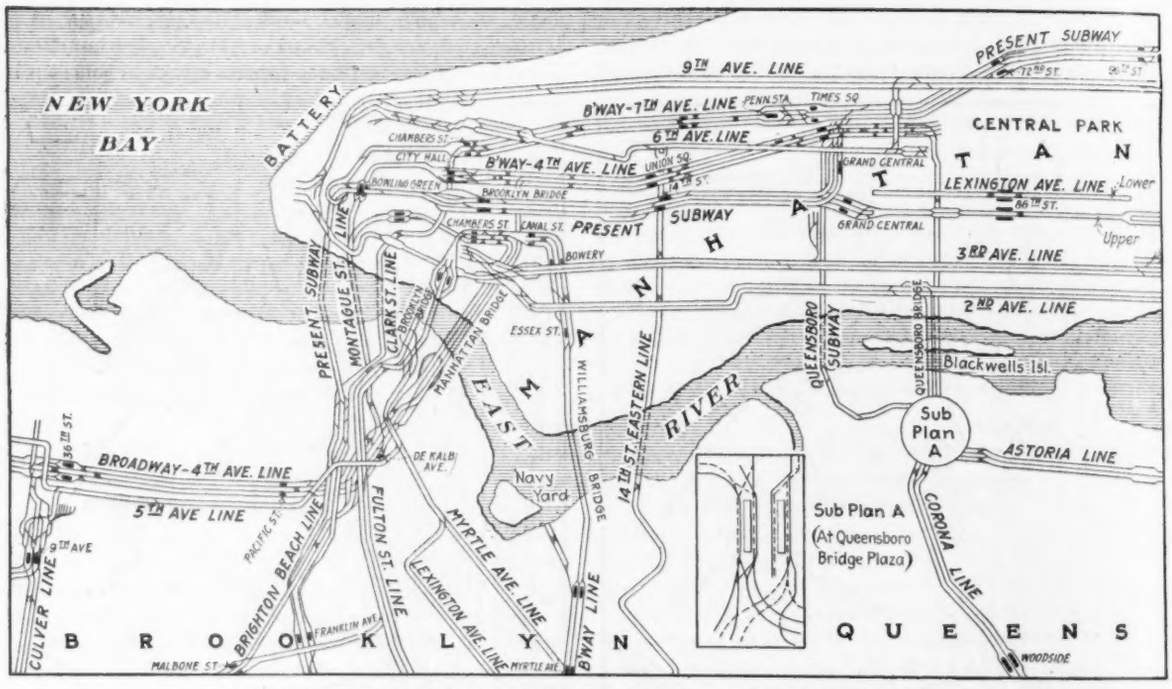


FIG. 3. TRACK SYSTEM IN HUB OF NEW YORK RAPID-TRANSIT SYSTEM

Seventh Ave. Line

The existing subway on Broadway will be extended south from Times Square under Seventh Ave., Seventh Ave. extension, Varick St., West Broadway and Greenwich St. to the Battery, where a connection will be made with the present subway loop. Its eight contract sections aggregate $14,793,449.50 in construction value. It is a four-track subway north of Park Place, the two outer tracks continuing south from Park Place to a connection with the present South Ferry loop. Actual construction

was started on these different sections at various dates in 1914, and exclusive of the connection at Times Square (which was finished within the past year) the work is from 51% to 84% completed.

The construction of the Times Square connection involved the entire removal of the west wall of the present subway between 43rd and 44th St. and the reconstruction of a large portion of the roof of the present subway within these limits. Like the Diagonal station work, it had to be prosecuted without interruption to traffic in the present subway.

The Seventh Ave. line is being built in trench under timber street decking, excepting within the limits of Battery Park and in Varick St. Extension and Seventh Ave. Extension—new streets not yet graded—and in the widened portions of Varick St. Rock has been encountered on all the sections north of 16th St. and in Battery Park; otherwise the material excavated consists in general of sand, gravel and clay, with occasional boulders. Filled ground was encountered in places, particularly south of Vesey St. along Greenwich St., which marks approximately the old shore line of the Hudson River during the days of the Revolution. For some distance north and south of Franklin St. a peat bed several feet thick was found, in which a number of well-preserved cedar logs and stumps were embedded; the peat was covered with 15 ft. or so of filled ground. The disposal of excavated material is being handled by the usual method of shafts and hoisting plants located at intervals along the line of the work.

Considerable underpinning of buildings has been required, particularly on the lower sections through Greenwich St., where many of the buildings are old and have shallow foundations. A special feature of this work was the underpinning of two lines of columns supporting the existing elevated-railroad structures along Greenwich St. and West Broadway.

Park Place and Beekman St. Branch

The two middle tracks of the Seventh Ave. line turn east at the northeast corner of Park Place and West Broadway, thence pass under Park Place, cross under the new double-deck Broadway subway, the general post office and the existing subway in Park Row, go by way of Beekman St., William St. and Old Slip to a pair of tunnels under the East River to Brooklyn and by way of Clark St. and Fulton St. to a connection with the existing subway at Borough Hall.

Because of the necessity of passing under the Broadway and Park Row subways the grades in Park Place and Beekman St. are as steep as 3%, and the structure is deep—about 60 ft. below the street surface under Broadway. An island-platform station at Church St. will, on account of the depth, be provided with escalators.

In Park Place and in the easterly portion of Beekman St. the work is being carried on in trench under timber street decking; the rest of the section, exclusive of the work under the post office, is being built in tunnel. The excavated material generally is sand, and subgrade is below groundwater level.

The portion of the two-track subway under the post office is built in a cut opened through the floor of the sub-basement of the building and passes below three rows of cast-iron columns of the building, the center line of the subway being directly below the middle row of columns. The cast-iron bases of these columns are in the sub-basement floor and rest on 12-in. granite caps 4½x 4½ ft. square, supported on continuous concrete footings about 10 ft. wide and 4½ ft. deep. The concrete floor is cut away between the lines of columns, and 15-in. transverse latticed girders incased in concrete are placed between the lines of columns under the granite caps, one girder on each side of each column. Directly under the 15-in. girders are placed 30-in. continuous longitudinal latticed girders, one on each side of the granite bases of each row of columns. In the order of underpinning operations the 30-in. girders are placed first. The placing of these longitudinal girders involves cutting away a portion of the existing concrete footings on each side of the lines of columns, in order to place the girders near enough to the columns. The concrete is then replaced, inclosing the girders and making them integral portions of the footings. For the purpose of bonding the concreted girders to the

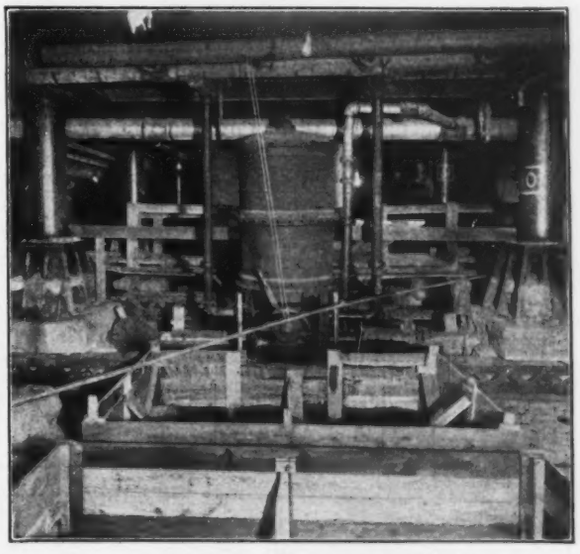


FIG. 4. SUBWAY WORK IN SUB-BASEMENT OF DOWNTOWN POST OFFICE

footings, dowel pins 1¼ in. square and 36 in. long are driven into holes drilled horizontally 18 in. into the concrete footings.

The footings are carried down by means of underpinning pits 5 ft. square to the proper depth, usually to groundwater level, below which 14-in. concrete piles are put down. Above subgrade these piles will be incorporated in the walls of the completed subway structure. The subgrade of the subway is 30 ft. or more below the sub-basement floor of the building. The estimated loads coming upon these building columns vary approximately between 350 tons and 800 tons per column. Fig. 4 shows the work in the sub-basement of the post office.

Work between West Broadway and William St. was started in December, 1914, and is now over 39% completed. The contract bid price was $1,571,363.50.

A special feature of the work under William St. is underpinning of buildings. On account of the narrowness of this street, which is about 40 ft. wide between building lines, every building along the line has to be underpinned. These buildings vary in height up to 20 stories. The method of underpinning was described quite fully in *Engineering News* of Apr. 13, 1916, p. 681.

Work in William St. started in December, 1914, and is now about 59% completed. The contract bid price is $2,254,670.

East River Tunnels

The Old Slip-Clark St. tunnel is 5,900 ft. long and is made up of two single-track cast-iron-lined tubes, 17½ ft. in external diameter. Work on this section started in August, 1914, and is now about 35% completed. On the Manhattan side, shafts are located in the north and south roadways of Old Slip at Front St. On the Brooklyn side a double shaft is located at the foot of Clark St., partly in Furman St. (Fig. 9). These shafts have been sunk as caissons under compressed air, with walls of steel and concrete, and will be used in the permanent structures as emergency exits and ventilation shafts.

Four headings are being driven from the Manhattan shafts, two toward the river by use of shields and two landward by a crown-bar system of poling and breasting. The river headings are in rock in the lower portion of the tunnels, while their upper portion is in river mud and filled ground containing old foundations, piles and cribbing. On the Brooklyn side where the excavation is in sand, four headings—two landward and two toward the river—are being driven by the use of shields.

Just south of the Old Slip-Clark St. tunnels is another pair of tunnels under construction from City Hall St. (Manhattan) to Montague St. (Brooklyn), forming a portion of the New York Municipal Railway system. Both pairs of tunnels are being built by the same contractor.

Brooklyn and Queens Lines

A four-track extension of the present subway from its terminus at Flatbush and Atlantic Ave., Brooklyn, passes along Flatbush Ave. and Eastern Parkway to Buffalo Ave., with a two-track branch subway along Nostrand Ave. from Eastern Parkway to Flatbush Ave. The portion of the subway under Flatbush Ave. from Pacific St. to the Prospect Park Plaza will be a six-track structure, two tracks of which will be used by the New York Municipal Railway Corporation. These two tracks at the northerly end will pass directly under the Long Island R.R. terminal and by way of St. Felix St. will connect with the subway under Fulton St. coming from Manhattan Bridge, while at the southerly end they continue under Flatbush Ave. for a distance of a little less than one mile beyond the Prospect Park Plaza as far as Malbone St.

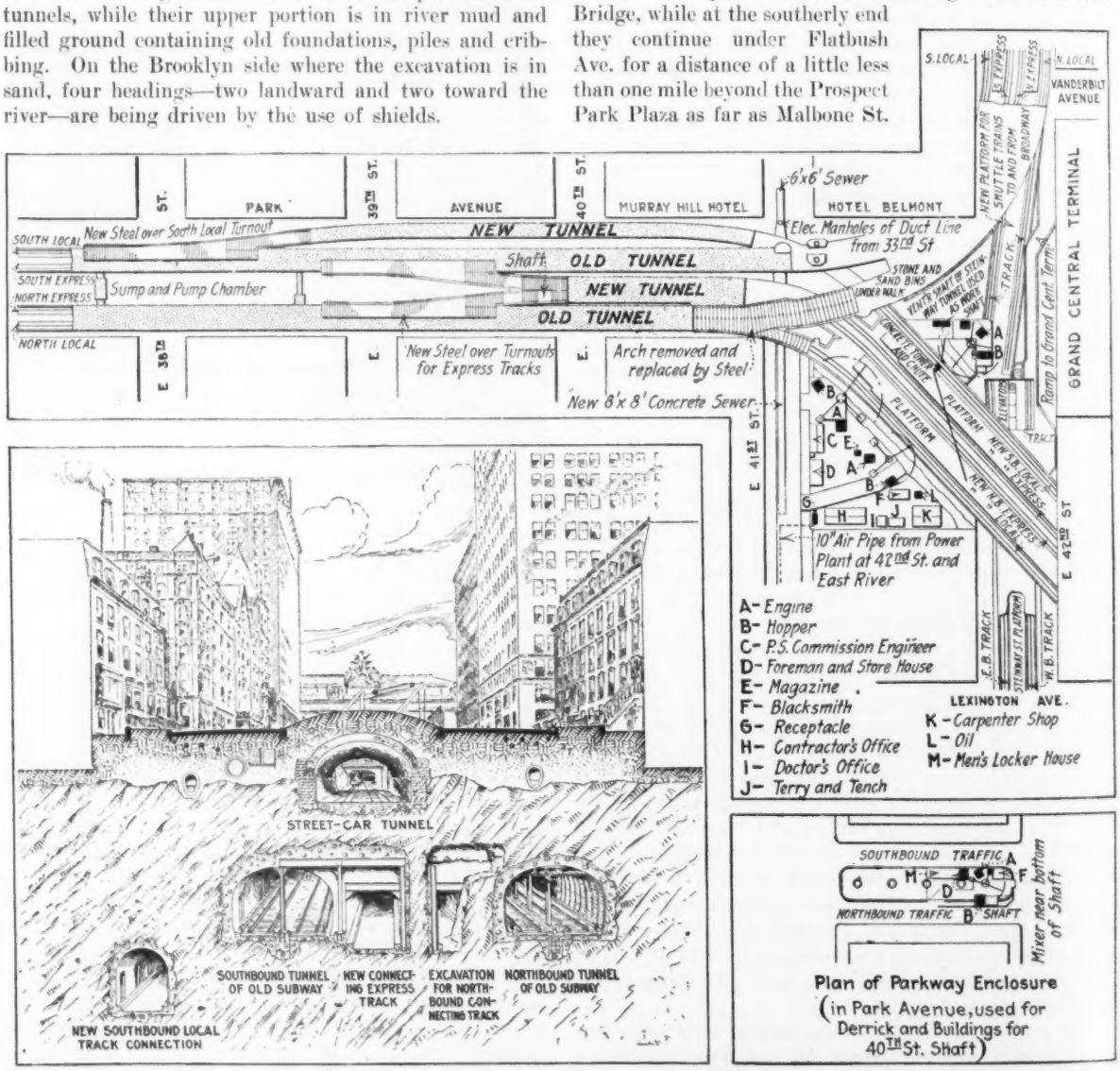
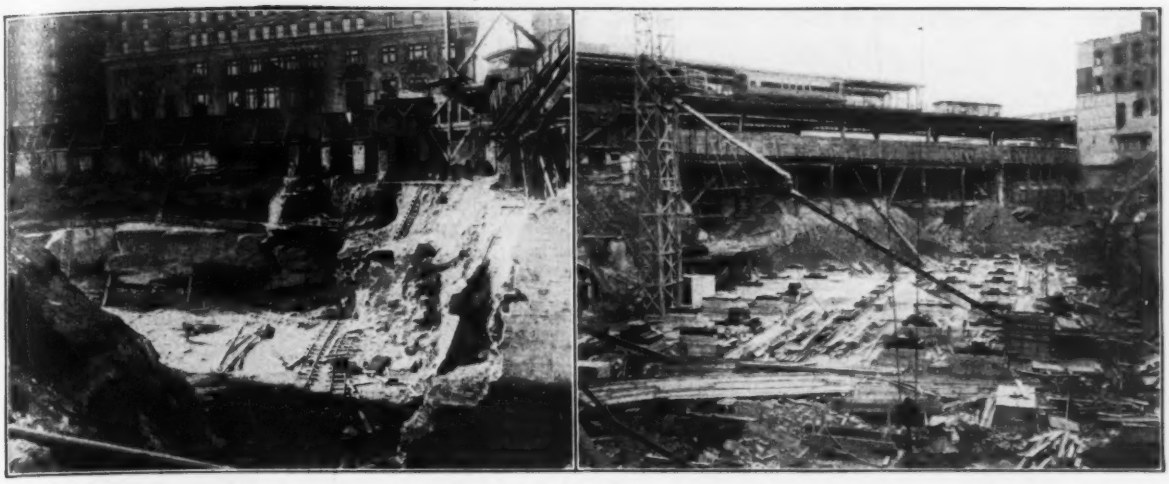


FIG. 5. DIAGONAL STATION AND TUNNEL CONNECTION TO EXISTING SUBWAY AT 42ND ST. AND PARK AVE.

The two double-track tunnels on either side of Park Ave. are the present subway curving west into 42nd St. Grand Central Station is just beyond the curve. The middle of Park Ave. is occupied by a double-track tunnel for street cars, with portal at 41st St. The new tunnels from Diagonal Station pass under these existing structures



FIGS. 6 AND 7. TWO VIEWS OF DIAGONAL STATION WORK, GRAND UNION HOTEL SITE
Left—Looking southwest. Right—Looking northeast

All this line is now in progress and is in various stages of construction, with the exception of the section under Flatbush Ave. between Prospect Park Plaza and Malbone St., which will be in soft-ground tunnel.

The Flatbush Ave. portion from Prospect Place to the Plaza, which was the first section let, is about 64% completed. Some of the other sections have only recently been let. Construction is being prosecuted in trench under street decking generally. Along Eastern Parkway, work is generally prosecuted in open cut. The excavated material is largely sand, gravel and clay.

The old two-track Steinway tunnel is being continued by a two-track subway extension westerly under 42nd St. to Times Square and by a two-track elevated extension from the easterly end in Long Island City, passing through the yard of the Long Island R.R., Davis St. and Ely Ave. to the Queensboro Bridge Plaza, where a junction is made with a two-track line from the bridge coming from the Second Ave. elevated line in Manhattan. From the Bridge Plaza two three-track elevated lines branch out into Queens—one over Jackson Ave. and Second Ave. to Astoria and the other along the Queens Boulevard,[1] Greenpoint Ave. and Roosevelt Ave. to Corona. There is a large double-deck union station on the Bridge Plaza under construction.

All of the Queens lines were started in 1913 and are now nearing completion. The work along Second Ave. to Astoria has already been finished.

New York Municipal Railway Corporation Lines—Broadway-59th St. Line

From the Manhattan end of the Whitehall St.-Montague St. tunnel a new subway extends north through Whitehall St., under Bowling Green, private property, Trinity Place, Church St., St. Paul's vestry building and churchyard, Vesey St., site of the southerly half of the old Astor House, Broadway and Seventh Ave., thence easterly through 59th St. to a point west of Fifth Ave. and curves diagonally across Central Park and the Plaza to 60th St., thence east to the East River and by tunnel under the river to Queens, where connection will be made with the Queens lines at the union station in Queensboro Plaza.

[1]The concrete-arch viaduct section of elevated railway along Queens Boulevard was described in "Engineering News" of Nov. 11, 1915, p. 913. The steel elevated railways were fully treated as to design in the issue of May 20, 1915, p. 971.

The portion of the subway on 59th St.—a two-track structure east of Seventh Ave.—as originally planned called for single-track tunnels in 59th St. and 60th St. between Fifth and Second Ave. These tunnels were to connect with the Queensboro Bridge, over which this line was to extend into the Borough of Queens. Objections to the use of the bridge for this purpose led the Board of Estimate and Apportionment to request that this line be carried in a tunnel under the East River. Accordingly a new two-track location was made across the Park Plaza and through 60th St., as outlined above.

The entire line is a two-track subway south of Park Place and (in general) a four-track subway north of Park Place as far as 59th St. Provision is made for a possible future extension of this line north of 59th St. to Central Park West and thence north; at present ony two of the four tracks continue across 59th St. Provision is also made at Canal St. for a connection with a two-track cross-town subway east of Broadway, which will connect with the Fourth Ave. subway in Brooklyn by way of the Manhattan Bridge.

Work on the Canal St. subway is now about 54% completed.

All the work on the Broadway-59th St. subway south of Union Square was started at various dates prior to 1914 and is now nearing completion; a number of the sections have already been finished. All sections north of Union Square are under construction. The last to be let—the section from 38th St. to 51st St.—passes beneath the Times Square station of the existing subway, which is on a curve turning from 42nd St. into Broadway.

The depth of excavation for this section varies from 44 ft. at 42nd St. to 24 ft. in the vicinity of 51st St. The rapid rate of progress required to complete this section on contract time and the excavation in uncertain New York rock in safety and without undue interference with traffic and adjacent property in one of the most congested portions of the city make the construction of this section especially interesting. Work began under this contract in the latter part of last year and is now well under way. The contract bid price is $3,740,913.50, and the contract time is 20 months for the completion of the railroad ready for operation.

The Broadway-59th St. line continues south of Morris St. under Whitehall St., by way of the new East

River tunnels to Montague St. in Brooklyn and thence by way of Montague, Fulton and Willoughby St. to a connection with the Fourth Ave. subway at Flatbush Ave. extension. This portion of the line is from 21% to 35% completed. Its final construction value is $11,429,143.50.

Work on the section including the tunnels began in July, 1914, and is now 35% completed. On the Manhattan side of the tunnels there are two shafts—one at Whitehall St., sunk as a temporary timber structure, and one in the slip at the foot of Broad St., sunk as a permanent reinforced-concrete structure which will be used in the completed work as an emergency exit and ventilation

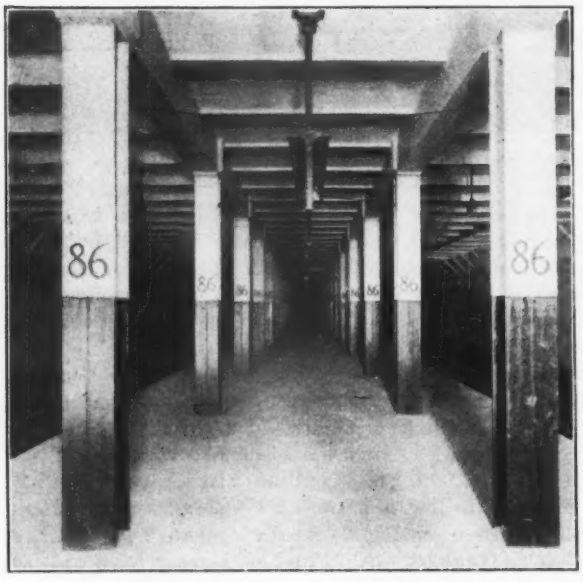


FIG. 8. INTERIOR OF FINISHED TWO-TRACK SUBWAY STATION, FOURTH AVE. LINE, BROOKLYN
View taken Jan. 14, 1916

shaft. On the Brooklyn side a permanent shaft of steel and concrete has been sunk as a caisson near the foot of Montague St.

All headings from the Manhattan shafts are in rock and are being excavated by the usual top-heading-and-bench method. The Brooklyn headings are in sand and are being driven by shields under compressed air, two landward and two toward the river. Work on this section includes the construction into Broad St. of a two-track spur which will be extended later by way of Broad and Nassau St. to a connection with the Center St. loop in the vicinity of Brooklyn Bridge.

Brooklyn Elevated Lines

A two-track railway will run from Sixth Ave. in Manhattan easterly under 14th St., passing beneath the new Broadway subway and the present subway in Fourth Ave. and by tunnels under the East River to Brooklyn, thence by way of North 7th St., Metropolitan Ave., Bushwick Ave. and Johnson Ave. to about Waterbury St., all in subway; beyond this point the line will continue as an elevated structure along Johnson Ave. and the right-of-way of the Long Island R.R. to a connection with the existing Broadway elevated line, serving the Eastern District.

A contract was recently let for the East River tunnel portion, extending from Avenue B in Manhattan to Bedford Ave. in Brooklyn. The bid price for this section was $6,639,023.50, which includes the construction of two single-track cast-iron-lined tunnels. Contracts for other sections of this line will follow shortly.

The New Utrecht Ave. line is a three-track extension of the Fourth Ave. subway in Brooklyn, passing easterly in cut between 37th and 39th St. to Tenth Ave. and to 86th St. and Stillwell Ave. to a connection with the existing lines to Coney Island. The construction of the entire line, which was begun early in 1914, is now practically completed.

The Gravesend Ave. line, another three-track elevated structure from the Fourth Ave. subway to Coney Island, has only recently been placed under contract; construction is less than 10% completed.

Sewer and Subsurface Construction

The building of subways and elevated lines necessarily involves much maintaining and reconstructing of existing sewers and piping. A great deal of such work has been done within the past year.

It is the practice, as a matter of precaution against possible explosions, to kill all gas mains preparatory to subway construction where such mains would otherwise have to remain underneath the street decking. These mains are temporarily bypassed, generally along the gutters, except that large bypasses are supported on timber bents above the sidewalk. Frequently at important street intersections where cross-mains have to be taken care of and long spans are necessary so as not to interfere with traffic, different means of supporting the gas bypasses are used. At the north side of 42nd St. across Times Square the bypass pipe is supported by two continuous 1½-in. suspension cables in three spans, the longest of which is 115 ft.; across Broadway between 33rd St. and 34th St. a steel truss is used with a span of 100 ft.

Not only do existing sewers have to be maintained or reconstructed on account of subway construction, but in some instances conditions require the building of new sewers to take the flow of sewers interfered with. Among the more important work of this class within the past year is the construction of the 30th St. off-line trunk sewer at a cost of about $500,000. This sewer extends from Seventh Ave. to the North River and will take the flow of various sewers between 20th and 39th St. Its maximum section is 11x6 ft. of reinforced concrete.

The construction of a new deep relief sewer at an approximate cost of $350,000 has been in progress within the past year through 41st St. from Park Ave. to the East River. This sewer will be built of concrete masonry and will have a maximum horseshoe section 8x8 ft. A portion of it east of Park Ave. will be built by the Public Service Commission and the remainder by the Manhattan Bureau of Sewers. A relief sewer is also under construction in 46th St. from Broadway to the North River, a part of which will be built by the Manhattan Bureau of Sewers. Its maximum section will be 9½x9 ft., horseshoe, and 8½x6½ ft. twin rectangular section.

The interior finish of stations and the installation of tracks are being done under separate contracts. A great deal of this work is in progress at present; some sections are practically done.

Operation of New Lines

Work on the Fourth Ave. subway in Brooklyn was started prior to the signing of the Dual-System contracts, and most of the line was practically finished before that time. It is a four-track line as far as 65th St., where

connection is made with the Sea Beach line to Coney Island and a two-track line from 65th St. to the present terminus at 86th St.

Work on the remainder of the Fourth Ave. subway from 43rd St. to 86th St. was completed within the past year, including the connection with the Sea Beach line, making possible the operation of the Fourth Ave. subway. Two of the four tracks are used. On June 19, 1915, through operation was commenced from the Chambers St. station in the basement of the Municipal Building, Manhattan, to Coney Island by way of the Center St. loop, Manhattan Bridge, Fourth Ave. subway and Sea Beach railroad. During the rush hours six-car trains are now operated on a 4-min. headway. Trains have recently been operated south of 65th St. to 86th St.

Operation of the Center St. loop had previously been commenced, on Aug. 19, 1913, over the Williamsburg Bridge, connecting with the existing Broadway elevated line in Brooklyn.

Within the past year the contract work for the alteration of the old Steinway tunnel to permit the operation of subway cars was completed, and on June 22 this tunnel, officially known as the Queensboro subway, was put into operation from the station under 42nd St. near Lexington Ave. to Jackson Ave. station in Queens. Operation has recently been extended to the Hunters Point Ave. station. The service consists of two-car trains on 2-min. headway during rush hours, and single cars are operated at longer intervals during the rest of the day.

The work of third-tracking the Second, Third and Ninth Ave. elevated lines in Manhattan and the Bronx, a part of the Interborough's system, was completed within the past year by the company, and recently the new express service has been put into operation.

Extensive work of reconstruction and extension of existing elevated lines in Brooklyn is in progress by the New York Municipal Railway Corporation, and within the past year a considerable amount of this work was finished. In February, 1915, a new elevated line to Lutheran cemetery was opened, and in September, 1915, an elevated extension out Liberty Ave. to Lefferts Ave. was also put into operation.

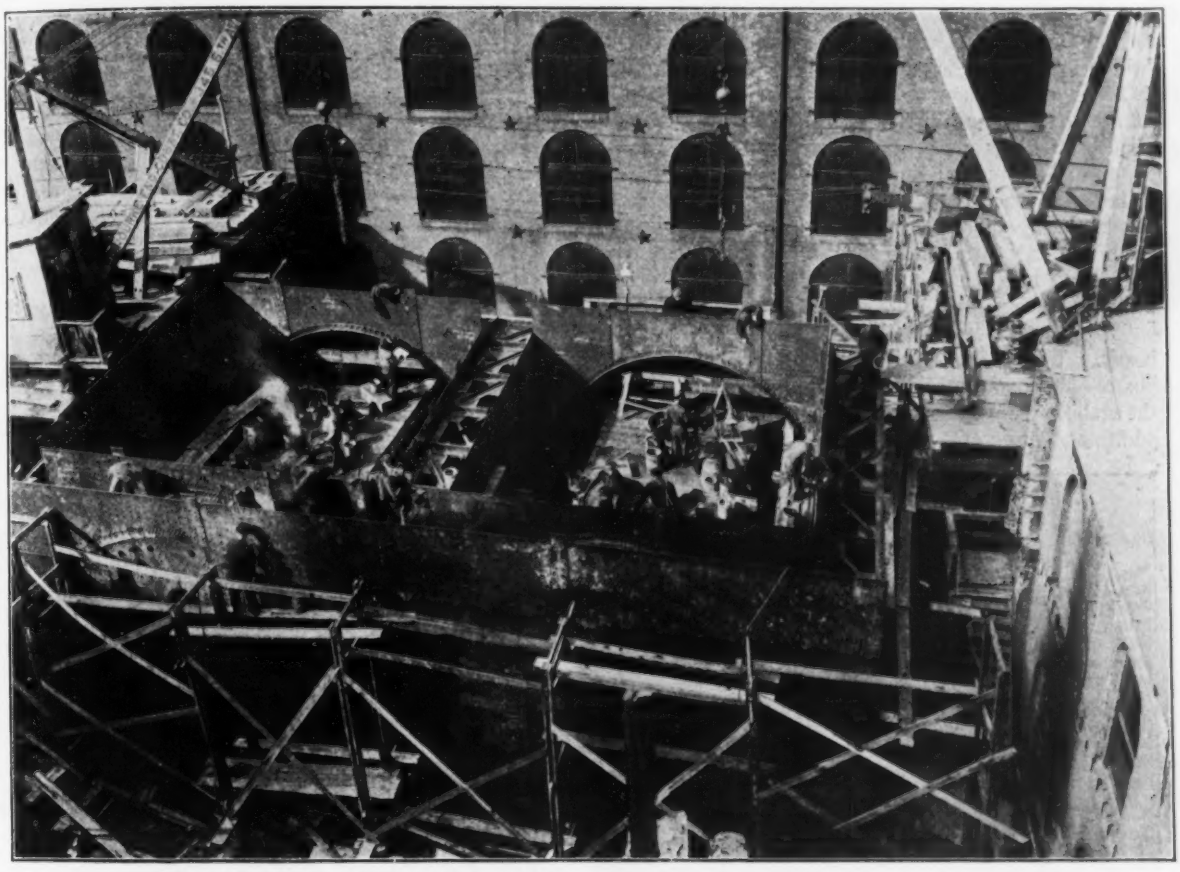


FIG. 9. SINKING CAISSON FOR TUNNEL SHAFT AT FURMAN AND CLARK ST.

When the System Will Be Completed

The greater part of rapid-transit work will have been completed by the end of 1917. Operation of portions of the system, however, is contemplated before that time. It is expected that some of the new lines will be placed in operation during the present year, such as the elevated extension of the West Farms branch of the present subway along White Plains Road from 180th St. to 241st St. in the Bronx; the new elevated lines in the Borough of Queens from the Bridge Plaza to Astoria and to Corona; and the New Utrecht Ave. line as far as the Sea Beach railroad.

The design and construction of the various lines in the Dual System are under the direction of Alfred Craven, Chief Engineer, Public Service Commission.

Field and Office

Century-Old Floating Bridge Sinks Deeper Each Year

A floating bridge built in the first decade of the nineteenth century is still in service across Glenmere Pond on the main road between Lynn and Salem, Mass. The bridge is a timber structure 28 ft. wide and originally 511 ft. long, but now reduced to about 400 ft. by filling at the shores. As built it was a solid timber structure about 5 ft. thick made up by spiking together successive layers of longitudinal timbers. As these timbers became waterlogged they gradually sank and as they sank new planks were year by year added to the roadway until now the bridge is reported to be about 28 ft. thick and extends well down into the bog bottom, which was the original impediment to bridge piers or pile footings.

The crossing is now much used and the traffic is very heavy. Under the heaviest loads—such as well-filled busses—the roadway disappears in water, but otherwise the stability seems assured. Frequent renewals or rather additions, however, make a new bridge economical.

FIG. 1. SUBMERGED ROADWAY OF GLENMERE POND BRIDGE

Coke Concrete Found Strong After Seven Years

By Kenneth A. Heron*

About seven years ago the writer was called upon to underpin the front wall of a battery of coke ovens at Segundo, Colo. It has been the custom to "pull" the ovens by hand previous to that time, and certain changes were necessary to be made in the wharf level to provide for the installation of coke-pulling machines. In order to lower the wharf level 2 to 3 ft. as planned, it was required to extend the face wall lower with a suitable foundation, as the original construction did not contemplate the removal of the material in front of the wall so as to expose its toe. The underpinning was to extend at least 2 ft. below the new wharf level and, being thicker than the old wall, was to be carried up the face a short distance.

Suitable sand or gravel could be obtained only by shipping in from outside points at considerable expense. There was available, however, at the plant large quantities of coke breeze—waste coke too small for furnace purposes—ranging in size from dust to about 1 in. Coming directly from the ovens, it was clean and free from vegetable matter; and it was accordingly adopted for use as concrete aggregate, in the proportion of six parts coke to one part cement, for the new footing.

The mixture when wet formed a mass of brownish color weighing about 80 lb. per cu.ft. It was very easily mixed, handled and placed in the forms and when hardened and brushed with cement grout resembled ordinary sand and rock concrete, although not obtaining as hard a set. A week or ten days after placing, however, it would resist quite a sharp blow without fracture and carried the load of the heavy wall without any appreciable settlement.

An examination recently showed that the mass had hardened to a degree approaching the strength of the

*Chief Engineer, Goose Lake Valley Irrigation Co., Lakeview, Ore.

FIG. 2. OLD FLOATING BRIDGE ACROSS GLENMERE POND, NEAR LYNN, MASS.

coke, and, while chipped and broken off in places exposed to heavy wear, was serving its purpose very well.

Since this work was done, coke concrete has been used for a number of other purposes in some of the other southern Colorado coal and coke plants. At Tabasco one of the fuel companies has erected a large number of coke-concrete blockhouses, and I am informed that they are much drier and more satisfactory than are stone-concrete block structures. The cost of making the blocks was about two-thirds the estimated cost of stone-concrete blocks.

Cornice Runways for Swinging Scaffolds from Buildings

The maintenance of large buildings, such as offices, stores, hotels, etc., involves periodical cleaning, painting and pointing, and also the washing of windows. This work is done usually from swinging scaffolds suspended from hooks or timbers on the roof. Where these supports are of a temporary character, they involve delay and trouble in rigging. Two methods of providing permanent supports, which give greater facility and economy, have been developed by Holabird & Roche, architects, of Chicago.

The building for the John Taylor Dry Goods Co., at Kansas City, Mo., is equipped with a permanent runway along the cornice, upon which travel trolleys from which the scaffold rigging is suspended, as in Fig. 1.

The runway is an angle 2½x2½x⅜ in., attached to the outer ends of T-bars that are spaced 5 ft. apart and have their inner ends anchored to the steel framing of the building. The trolley is composed of steel bars carrying a pair of 4½-in. grooved wheels. To the lower ends of the bars is riveted a plate for the attachment of the scaffold rigging. The inner end of the trolley frame is bent to engage a 1x1-in. guard angle, so that the trolley cannot be pulled over. This device is designed to carry a test load of 1,000 lb. at any point.

The Mandel Brothers Building, in Chicago, has both fixed and movable supports for the scaffolds. For the former there is a 3x4-in. runway angle carried by cantilevers of 5-in. H-beams attached when required to the steel frame of the cornice and roof. This equipment is shown at the top in Fig. 2.

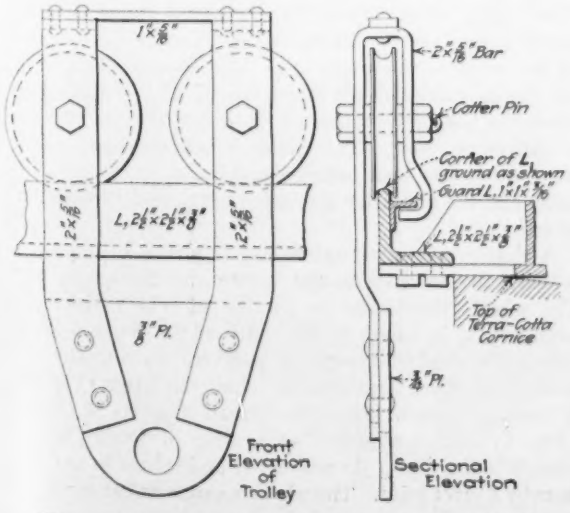


FIG. 1. RUNWAY AND TROLLEY FOR SWINGING SCAFFOLDS ON THE TAYLOR BUILDING

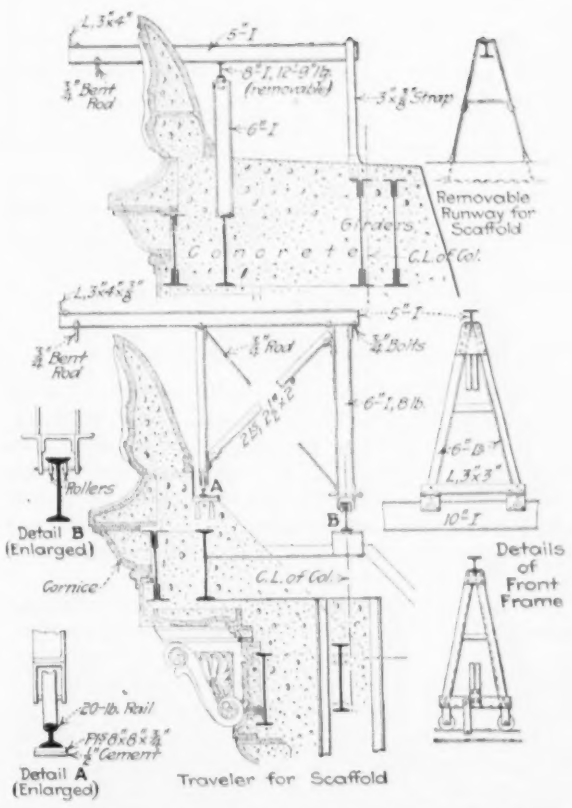


FIG. 2. SUPPORTS FOR SWINGING SCAFFOLDS ON THE MANDEL BUILDING

The upper drawing shows a removable runway. The lower drawing shows a traveling carriage

For the movable supports, on a newer portion of the building, there is behind the cornice a track on which travel carriages having cantilever beams that project over and beyond the cornice, as shown in the lower drawing of Fig. 2. The cantilevers form attachments for the scaffold rigging. The carriage is composed of two A-frames, connected by bracing and carrying the cantilever beam. The forward frame has grooved rollers running on a 20-lb. rail, while the rear frame has two pairs of 3-in. rollers riding under the flanges of a 10-in. I-beam and so forming the anchorage.

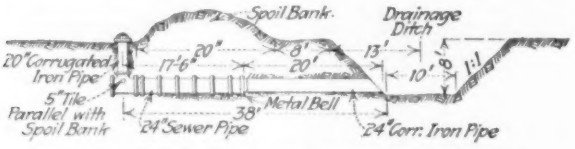
Surface-Water Ditch Outlet

The surface-water intake and tile outlet protection shown herewith are designed to admit surface water into an open ditch without eroding the banks or carrying off surface washings from adjoining fields. Ordinarily, surface water would be held back by the spoil bank or would cut through it and through the berm. This arrangement was devised by John T. Stewart, Chief of the Division of Agricultural Engineering at the University of Minnesota, St. Paul, Minn.

Corrugated metal pipe is used on the outlet end. This is in a long section and will not become displaced by the flow of water in the ditch. The grade is 1 in. in 10 ft. As nearly all large open ditches are constructed with a view to tile drainage of the adjoining lands, the pipe

should be placed at such a depth that it can be used as an outlet for the tile. After the tile system has been installed, the catchbasin will serve to admit surface water during excessive rainfalls.

The spoil bank, after one or two years' weathering, should be plowed down, leveled and sown in grass and



DITCH OUTLET FOR SURFACE WATER, WITH CONNECTION FOR TILE SUBDRAINS

the grass permitted to grow from the outer edge of the spoil bank down the ditch slopes. The spoil banks should be left high enough to prevent surface water from flowing over them, causing all such water to enter the ditch through the inlet. They can be either fenced and pastured or used as meadow lands. Local conditions and the nature of the soil to a certain extent will determine which is the more desirable.

The tile lines running parallel to the open ditch and along the outer edge of the spoil bank are for the purpose of intercepting groundwater and preventing its entering the open ditch through the slope. They tend to keep the slopes dry and thus decrease the caving and slipping that occur where groundwater enters open drains through porous strata in the slopes.

Screen Cart for Broken Stone

The screening cart or traveling screen shown in the accompanying illustration is designed for use where old macadam paving is being torn up and used in making concrete for a pavement or foundation course. In such work the old stone is often hauled to a dump and wasted, and if hauled to and from a screening plant the cost may be almost as great as for new stone. With this cart, however, the old stone is screened while being hauled from the road to the stockpile at the concrete mixer, and a haul of the length of about a block is sufficient to clean the stone.

The screening drum is 40 in. diameter and 45 in. long, made of heavy wire netting with 1-in. mesh. Its capacity is 1⅛ cu.yd., but the load is ⅔ to ¾ yd. to allow free movement of the stone. The door is 17 in. wide, extending the full length of the drum. Loading is done best by forks, thus giving a preliminary screening. The drum is mounted between a pair of 5-ft. steel wheels with

SCREENING CART FOR CLEANING OLD MACADAM STONE

6-in. tread and revolves with them. The machine is 6 ft. wide over the frames and weighs about 1,000 lb. (including the pole). The driver stands on a step, or footboard, at the rear.

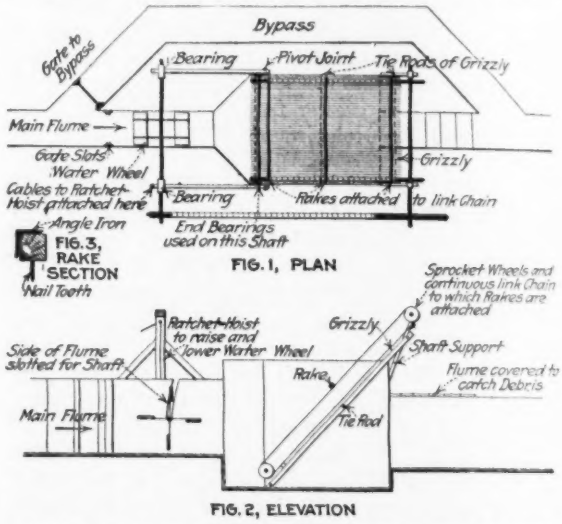
The illustration shows one of the carts used on work in Chicago, the cart being on the stockpile and ready to dump. This machine is built by the Briggs-Chicago Co., 108 S. La Salle St., Chicago, Ill.

Self-Cleaning Flume Screen

By H. W. Keith*

Where water for mining, irrigation, power or other services is conveyed by means of flumes, the paramount problem, generally, is the removal of the floating débris. The writer has found the self-cleaning screen described herein very satisfactory in the solution of this problem.

The first step in the installation of the screen is the construction of a bypass flume (Fig. 1) around the location



FIGS. 1 TO 3. SELF-CLEANING SCREEN FOR FLUMES

of the screen. About 10 ft. below the entrance to the bypass the flume is enlarged to almost three times its width. The length of this widened portion, or screen box, depends upon the angle at which the screen is inclined therein. The bottom of the screen box is placed at an elevation about 3 ft. below the bottom of the flume at the entrance of the latter to the screen box. The bottom elevation of the flume, on leaving the screen box, should be about 2 ft. above the bottom elevation of the latter, thereby forming a settlement basin. This basin is not absolutely necessary, but it has been found beneficial, as it catches sediment and the like after the water has passed through the screen.

A simple undershot waterwheel is placed in the flume between the entrance to the bypass and the screen box. The wheel—the blades or paddles of which are made nearly equal in length to the width of the flume, leaving only a practical clearance—is mounted on a shaft; the sides of the flume are slotted to admit the latter (Fig. 2). A bearing on each side of the flume supports the wheel (Fig. 1) and is mounted on a strip of timber, which extends to the side of the screen box and is held in position there by a pivot joint. The whole is supported at the oppo-

*Civil and Hydraulic Engineer, 1811 32nd St., San Diego, Calif.

site end by two small flexible cables, one attached to each bearing timber and connected overhead to a ratchet hoist (Fig. 2), by means of which the wheel can be raised or lowered according to the amount of water flowing.

A screen or grizzly, is placed in the screen box. It is composed of a number of flat strips of iron (4 × ¼ in. was found most effective) separated by washers, giving any desired opening, and bolted together with rods through the top, middle and bottom. This grizzly should occupy the entire width of the screen box. One end of the grizzly is placed on the bottom of the upstream side of the screen box (Fig. 2) and inclined at any satisfactory angle. A shaft is placed at the upper end, about a foot beyond the end of the grizzly and at a sufficient height above the plane of the face of the latter so that the two sprocket wheels placed on the shaft about 4 or 5 in. in from its sides will be nearly tangent to its face. A similar shaft is placed at the bottom end, so that the sprocket wheels will allow the rakes to come in contact with the grizzly about 6 in. above the bottom end. The corresponding sprockets on both sides are connected by a continuous chain belt to which rakes are attached at 6-ft. intervals.

The rakes are strips of wood, equal in length to the width of the grizzly, with nails driven through so as to fit into the slots and act as teeth. The strip is then weighted with a strip of angle iron (Fig. 3), the rakes being attached at either end by means of this angle iron to the link chains.

The upper shaft is connected to the waterwheel by means of a sprocket wheel and link belt and is geared to draw the rakes across the grizzly at the rate of about 4 ft. per min. The flume must be covered for a short distance below the screen box, in order to catch the débris.

Protecting Survey Monuments in Phoenix

City survey monuments of a satisfactory type have been developed in Phoenix, Ariz. The street lines are marked generally by center-line monuments or by offset lines from the center line which bring the monument in the street area. In paving the streets great care is taken not to disturb the monuments. First their location is ascertained, and then a man is stationed to watch that they are protected from the roller, wagons, etc. About 4 in. of the head of the monument is uncovered, and a concrete base 9 in. deep is formed around the top of the stone, leaving about 1½ in. of soil all around. A square cast-iron box is set in this concrete base. The pavement may then be constructed around the cover box without injury to the stone. The object of the 1½ in. of soil around the stone is to provide for the expansion and contraction of the pavement. It was found, however, that water getting in here sometimes resulted in displacing the stone, so a seal of 1½ in. of asphalt was added.

The boxing of the monuments as described is made a part of the paving contract. The record of the monuments, which serve for both line and bench marks, is kept in a special book. The city engineer is James B. Giraud.

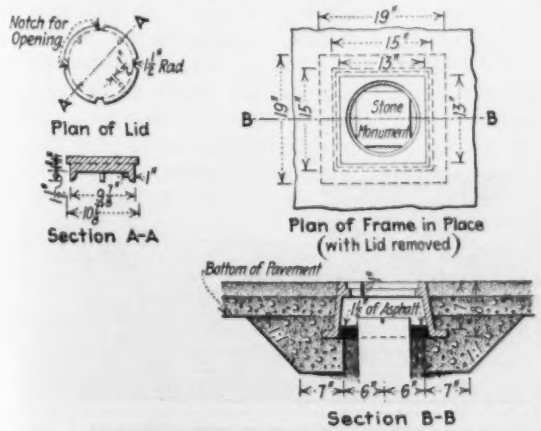
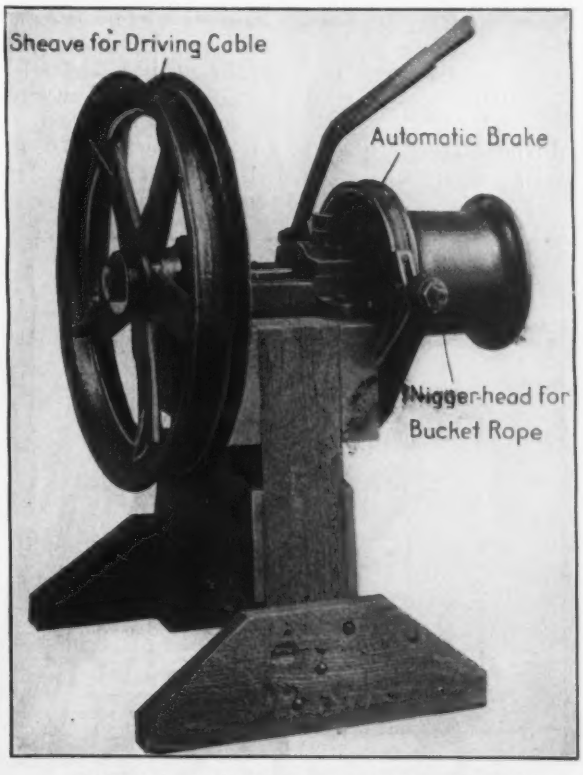


FIG. 1. CITY SURVEY MONUMENT AND BENCH MARK, PHOENIX, ARIZ.

Safety Brake for Hoists

In sinking the wells (locally known as "caissons") for the concrete foundation piers of large buildings in Chicago, a general method is to place over each well a hoist having a niggerhead for the manila rope of the bucket and a grooved sheave for a wire driving cable. The cable serves a series of hoists and is operated from a drum with a steam or gasoline engine or electric motor.

The method of operation is to wrap the driven cable once around the sheave, which is keyed to the shaft. The operator stands on the niggerhead side of the hoist and



FOUNDATION HOIST WITH SAFETY BRAKE

takes as many wraps of rope around the niggerhead as are necessary to lift the load. In case of fracture of the driven cable the automatic brake is set and prevents the bucket from dropping on the men at the bottom of the well. The lever is for applying the brake by hand in case the bucket rope gets fouled. This locks the niggerhead and the sheave, and the driving cable will then slip on the sheave. This safety device is used on hoists made by the Thomas Elevator Co., Chicago.

Piledriving Details on the Yolo Bypass Trestle

Hard driving was experienced in putting down the precast piles of the concrete highway trestle across the Yolo bypass in California, the construction of which is only just completed. The 2,940 concrete piles required for the structure were cast in a yard adjacent to the trestle and were hauled to the work by gasoline locomotives. Fig. 1 shows the piledriver and derrick about to take hold of a pile and swing it between the leads. The method of handling was to pick the pile up at the point by the boom fall line and at the head by the pile line. The pile then was swung clear of the track and placed in the leads by slacking off the boom line and picking up on the pile line.

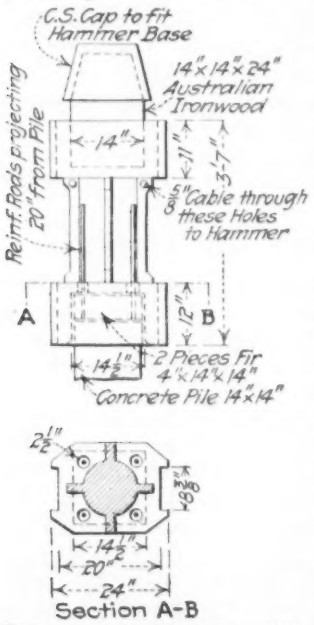


FIG. 2. CAST-STEEL FOLLOWER USED WITH STEAM HAMMER

A No. 1 Vulcan steam hammer was used for driving. This machine had a 3½-ft. drop and a 5,000-lb. ram, equipped with a cast-steel follower (Fig. 2). Hammer and follower weighed 12,500 lb. The piledriver was operated by an 8¼x10-in. American hoisting engine, but an additional 35-hp. boiler was found necessary to supply sufficient steam to the hammer for the hard driving. A summary of the piledriving results is as follows:

Pile Length, Ft.	Piles Driven	Number of 8-Hr. Driving Shifts	Average Piles per Shift
32	846	35	24
35	1,114	69	16
40	527	41	13
45	226	25	9
50	227	28	8
	2,940	198	15

It was required that the piles should be driven to grade if possible, without injury to the pile or the driving equipment, and that driving be continued until the penetration was not more than ⅓ in. per blow. These requirements made it necessary to cut off or splice many concrete piles after driving, in spite of test piles.

SPLICING OF CONCRETE PILES

Length of Splice Ft. In.	Ft.	Piles Spliced	Ratio of Piles Spliced to Piles Driven, %
.. ..	to 1	98	3.33
1 1	to 2	105	3.57
2 1	to 3	35	1.19
3 1	to 4	12	0.41
4 1	to 5	7	0.24
5 1	to 6	1	0.03
6 1	to 7	2	0.07
7 1	to 8	1	0.03
		261	8.87

CUTTING OF CONCRETE PILES

Length Cut Off Ft. In.	Ft.	Piles Cut After Driving	Piles Cut Before Driving	Total Piles Cut	Ratio of Piles Cut to Piles Driven, %
.. ..	to 1	40	..	40	1.36
1 1	to 2	49	..	49	1.67
2 1	to 3	37	..	37	1.26
3 1	to 4	18	..	18	0.61
4 1	to 5	15	15	30	1.02
5 1	to 6	16	14	30	1.02
6 1	to 7	16	32	48	1.63
7 1	to 8	4	1	5	0.17
8 1	to 9	3	27	30	1.02
9 1	to 12	5	..	5	0.18
		203	89	292	9.94

Ratio of piles cut and spliced to piles driven, 19%.

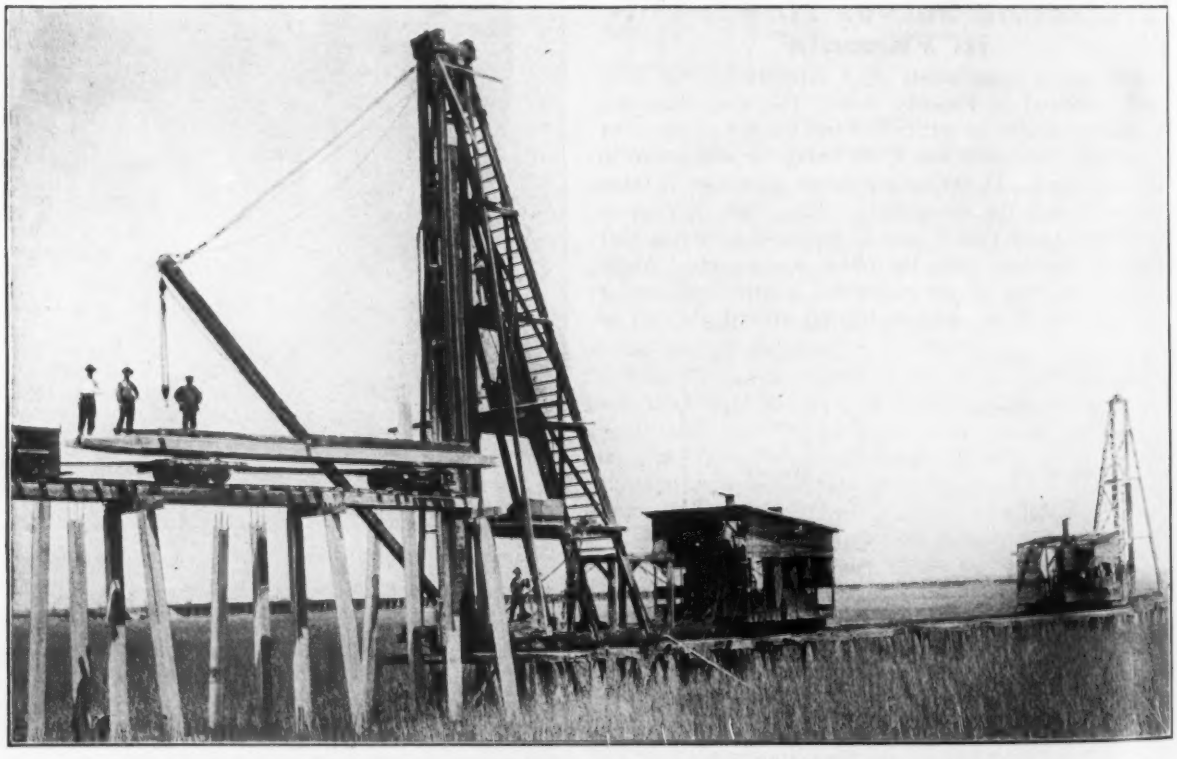


FIG. 1. ERECTING THE UNIT-CONSTRUCTION CONCRETE TRESTLE OVER THE YOLO BYPASS
After driving a bent of concrete piles, the larger piledriver was pulled back one span. The temporary wood piles in front of the machine were pulled and floated ahead to be redriven by the smaller piledriver

The trestle was built for the California Highway Commission by the Graff Construction Co., Seattle, Wash.; Horace W. Holmes, Superintendent.

Two Railing Details for Concrete Bridges

An open concrete railing—neither balustrade nor parapet—is used on many of the recent concrete bridges built by the Ohio Highway Department. It is called "Type D" railing (Fig. 2) and is shown on a standard sheet.

The railing is considered very successful as to appearance, especially on bridges whose waterway height is small. It is easy and cheap to build. The lowest price

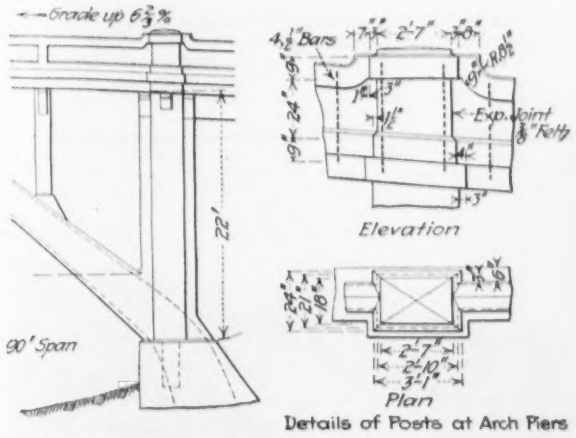


FIG. 1. TREATMENT OF RAILING AT PILASTER ON HEAVY GRADE, WILLS CREEK BRIDGE, CAMBRIDGE, OHIO

obtained last season was less than $1 per lin.ft. The open space, 15 in. high, is not regarded as dangerous on country road bridges.

The bottom rail is molded directly on the top surface of the coping or spandrel wall, but only the posts are bonded in by steel. The top-rail lengths are precast, and the posts are molded around them. Expansion of top rail in post is provided at intervals (not at every post).

Another interesting railing detail used by the department is shown by Fig. 1, from the Wills Creek bridge in Cambridge, a 90-ft. open-spandrel arch now under construction. The roadway is on 6⅔% grade and thus presents the old difficulty of joining a sloping rail to a post whose top is horizontal. At such a junction the opposite sides of the post project unequal distances above the rail unless the line of the railing is given a horizontal jog at the post, an expedient that in most cases is not practicable. The unsatisfactory appearance of the difference of heights of projection is neatly masked, in the Wills Creek bridge, by swinging the top line of the rail up to the post by a curve, as shown in the sketch.

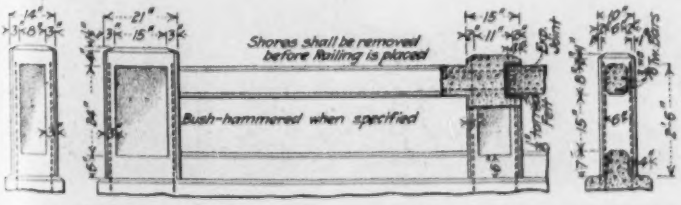


FIG. 2. OPEN RAILING USED ON OHIO ROAD BRIDGES (TYPE D, OHIO HIGHWAY DEPARTMENT STANDARDS)

NOTES

Concrete Footing Blocks for Sheeting Braces—A method of bracing the sheeting of retaining-wall excavations without leaving holes in the wall concrete was used in Detroit recently. The pit for a new screen chamber at the city water-works required to be sheeted, and this was so placed as to serve as outside form for the wall concrete. To avoid having to leave holes in the concrete at the braces of the sheeting, separately molded concrete blocks of the thickness of the wall were placed against the sheeting and the braces butted against them. The blocks were made with a slight taper, and the largest face was placed against the sheeting. After completion of the wall the blocks were keyed in by this taper.

Notice to Property Holders of Street Improvement—The city charter of St. Louis requires that in advance of all street improvements that are to be paid for by special taxation there shall be held a public hearing at which all interested property holders shall be invited to appear and express their views on the question of improvement and on the matter of materials to be used. It further provides for giving official notice for such hearings in the newspapers doing the city

STREET-IMPROVEMENT NOTICES SAVE TROUBLE

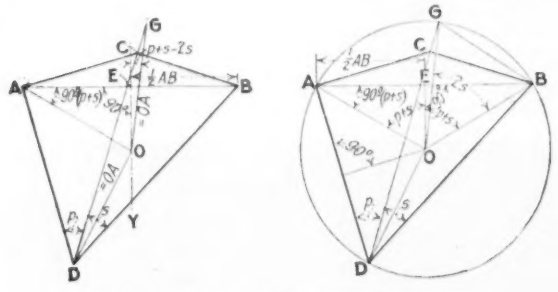
printing. As these notices usually appear in the advertising section and are rarely read, the city has this year carried out a scheme of special notification by having placards posted at each intersection of the street under construction.

In addition to the notice of the hearing, the placards carry an estimate of cost of the materials which the city is willing to consider. This estimate is contained in the oblong in the lower left side of the placard. Any property holder knowing the frontage and area of his lot can estimate in advance the cost to himself of each material and come to the hearing thoroughly informed. This procedure always brings out a representative meeting and eliminates any doubt as to the board's being acquainted with the desires of the affected property holders.

The sign shown is printed on heavy cardboard. It is paraffined and slipped into sheet-metal holders,

which are either wired or screwed to a post. The dates and the estimates are changed for each hearing, and the printed signs are used a number of times.

Three-Point Problem; A Graphical Solution—The location of a point fixed by observed angles to three known points —the well-known three-point problem—may be plotted without any calculation whatever, more accurately and easily than by the three-arm protractor or transparent paper. Construction: Let A, B, C, Fig. 1, be the three known points, and D the unknown point at which have been observed the angles p and s subtended by AC and CB. Plot the points A, B and C on the map and calculate or scale distance AB. Bisect AB at E and draw perpendicular EY. At A lay off from AB the complement of (p + s) with ordinary protractor, as angle BAO, intersecting EY at O. From O draw line OG equal to OA and making an angle with the perpendicular equal to (p — s). The point D is on line GC and at a distance from O equal to AO. Demonstration: In Fig. 2 the perpendicular bisectors of AB and AD meet at the center of a circle passing through AB and D. Drawing the radii OA, OB, it is seen that triangle OAB is an isosceles triangle, so that angle OAB = angle OBA. The angle AOB is twice the sum of the angles p and s since the chord AB subtends at D, on the circumference, only half the angle that it subtends at the center O. Hence, each of the angles OAB and OBA is the complement of (p + s). Producing DC to the circumference at G and drawing BG and radius OG, it will be seen that angle GOB is twice s, because the chord BG subtends angle GOB at the center and angle GDB = s at the circumference. But BOE is already found equal to p + s, so that angle p + s — 2s, or p — s, will be angle GOE, giving the direction of the point G. If the sum of angles p and s is greater than 90°, the center of the circle lies above AB, but the demonstration is the same. If 2s is greater than p + s, the angle EOG will be to the left of the perpendicular EY.—C. K. Averill, 34 Warburton Ave., Yonkers, N. Y.



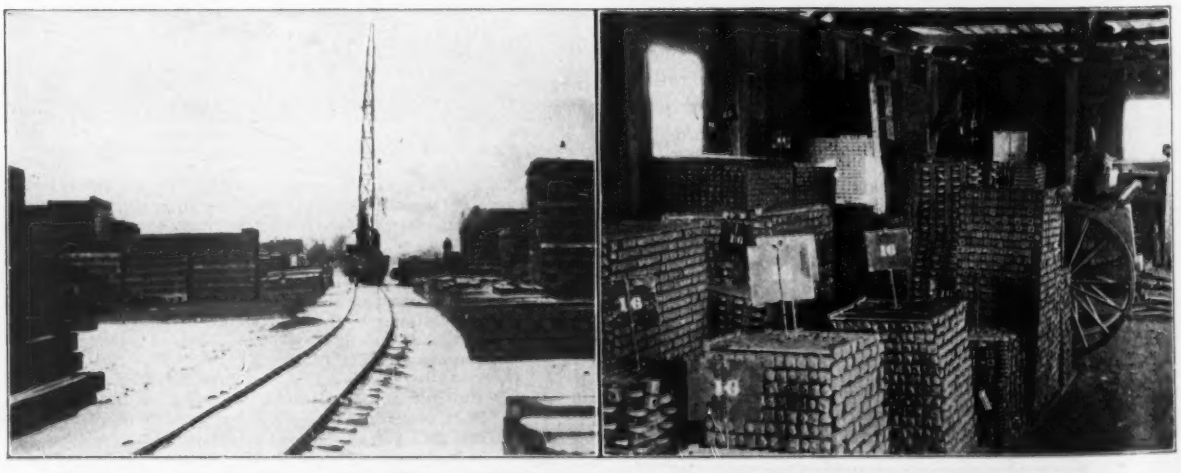
SOLUTION OF THREE-POINT PROBLEM

A Neat and Systematic Material Yard is that of the Atchison, Topeka & Santa Fé Ry. at Arkansas City, Kan. Unlike other model material yards, this one is a development from a single siding and was not originally intended for the purpose it now serves. All lumber is neatly piled and arranged in alleys fronting a track. Each pile of lumber bears a sign in black and white, giving all the dimensions of the sticks in that pile. The sizes are systematically arranged so that all of similar dimensions are adjacent. Treated (creosoted) timber is kept in a separate part of the yard. The yard also contains ties, piles, poles, etc. Bolts, pipe and other hardware are stored in houses. The bolts, as some of the illustrations shows, are neatly stored in square piles, each pile bearing a sign card of the size of the bolts in that pile. Throughout the yard are planted disk car-spotting signs. When a loaded car comes in or a car is to be loaded, the superintendent of the yard has merely to give the train crew the nearest spot number to the pile. This system reduces the "pinching" of the cars in the yard to a minimum. There is no plan of the yard, as the foreman carries in his head the location of the various articles. Sufficient material of every kind is kept on hand so that any bridge order can be filled complete and the whole shipment made at one time. There is a locomotive crane constantly in the yard to handle large timbers and piles. Fire protection is provided by a row of city fire hydrants on the south side of the yard. There are also two hose houses and outfits.

Large Siphon To Flood Coffer-Dam for Protection—At the construction coffer-dam at lock and dam No. 43, Ohio River, high water rises well above top of coffer-dam. The danger of sudden flooding of the works is forestalled by a large steel-pipe siphon for filling the coffer-dam in rising water.

SIPHON FOR FILLING COFFER-DAM IN RISING WATER; LOCK AND DAM 43, OHIO RIVER

The short, or intake, leg of the siphon is shown in the photograph. At the summit there is a steam injector for the siphon. The device was installed last year and has proved a success. Major John C. Oakes is engineer officer in charge.



EXTERIOR AND INTERIOR VIEW OF THE MATERIAL-STORAGE FACILITIES OF THE ATCHISON, TOPEKA & SANTA FE RY. AT ARKANSAS CITY, KAN.

Editorials

Why Hoop Concrete Beams?

In one of the huge reinforced-concrete girders carrying the new balcony in the rebuilt theater at Wilmington, described on page 834 of this issue, the designer thought it desirable to increase the compressive strength by inserting a spiral hoop in the upper part of the girder. This device is not new, but it is rarely resorted to, probably because of its doubtful utility. In commenting upon such a use of spiral reinforcement in 1908, *Engineering News* said editorially:

> Because hooped columns have, in a few published tests, shown a marked increase in strength over the straight reinforced columns is no reason for attempting to utilize a similar construction in beams. The tests show that there is no magical property in a spirally wound hoop which can increase the strength of inclosed concrete, but that it is probable that the higher loads withstood by concrete so reinforced are due to the tensional strength of the hooping steel brought into play by the concrete expanding laterally (according to the Poisson ratio) under the load which simultaneously causes it to compress in the line of application of stress. This preliminary compression in the upper flange of a hooped beam complicates the distribution of the moment between the concrete and steel and renders extremely doubtful the utility or at least the economy of so reinforcing a beam. To get the full strength of the concrete the steel must be designed, far above its economical proportion, to take care of this primary deflection in the concrete, always providing that the shifting neutral axis and modulus of elasticity in the concrete do not so complicate the stresses as to make exact analysis impossible.

In the eight years that have elapsed much has been learned about reinforced concrete, but nothing which would warrant any variation in the criticism then made. Hooping of columns adds toughness and raises the failure point—both of which increase the factor of safety. Hooping of beams may add toughness, but the raising of the failure point is, to say the least, doubtful. It is probable that the spiral steel could be used longitudinally to much better advantage.

Estimating Armor-Plate Cost in a Government Plant

The Senate bill appropriating $11,000,000 for the construction of a Government armor-making plant has not yet passed the House of Representatives, although it has been favorably reported by the House Committee in charge. While its passage by the House is probable, in view of the action taken by the Democratic caucus reported in our issue of Apr. 6, the questions involved in the engineers' estimates, on which this Congressional action is based, are of sufficient general interest to deserve discussion.

According to the testimony before the Senate Committee on Naval Affairs, the estimates made by Admiral Strauss, Chief of the Bureau of Ordnance, are for the construction of a Government armor plant with a capacity of 20,000 tons per annum and show that the *operating cost* of such a plant, run at full capacity year in and year out, would be $230 per ton of armor produced. This estimate is for operating cost only and contains no allowance for interest on the cost of the plant nor for taxes, insurance, depreciation and *obsolescence*.

It deserves emphasis at this time, when comparative estimates are frequently called for between the cost of Government, state or municipal operation of an enterprise and private operation, that the two computations should be made on the same basis.

Government operation has a certain advantage over private operation, unquestionably on account of the lower rate of interest at which the Government can obtain capital; but this rate of interest should always be included in the comparison. Furthermore, the rate of interest charged on a Government plant should be the natural rate and not some artificial rate that the Government may be able to obtain by the exercise of its special powers.

For example, because Federal Government bonds sell at a price that yields only 2% on the investment, it does not mean that the Government can actually borrow money at that figure in the open market. It means that, because of the freedom from taxation and because of the use of the bonds as a basis for bank circulation, an artificially low price for them is created. For this artificially low price, however, the Government and the public it represents must pay eventually in some other way. If, for example, a city issues bonds that are free of taxation to build a street railway and sells the bonds at a lower rate of interest because they are free of taxation, then that city or some other city will not receive taxes on the capital represented by those bonds which it would have received had the bonds been issued by a private corporation.

It must be evident that if a large amount of property in a locality is owned by the Government and is therefore free of taxation, the burdens of taxation must be heavier on the private property remaining. In comparing, therefore, public ownership with private ownership of a public utility something must be charged for taxes on the property in the case of the public-owned plant, not because such taxes will actually be paid out of its earnings, but because the public will lose the amount which it would receive were the plant owned by a private corporation.

Concerning the items of depreciation and insurance, there can be no question whatever that they exist just as much in the case of a Government plant as of one under private ownership. The Government may of course properly carry its own insurance, but the risk of loss from fire is there, nevertheless, and is as much a proper part of the expenses of operation as is the risk of injury to workmen and the compensation that must be paid on account of such risk.

But in considering the proposed Government armor-plate plant special attention ought to be paid to the matter of obsolescence. The annual charge for depreciation refers to the period of time at the end of which the plant will cease to become useful because of physical deterioration. The annual charge for obsolescence refers to the time at the end of which the plant will cease to be valuable because it is obsolete. There is no doubt that in

most engineering estimates made for private concerns as well as for the Government far too little allowance has been made for obsolescence. If anyone questions its importance in connection with Government work, he would do well to make a tour of Government property located in various parts of the country and see what uncounted millions the Government has invested in the past in works that today are out of date and out of use.

This question is a very practical question in connection with the proposed investment in a Government armor-plate plant. No one is wise enough at the present day to predict with any certainty for how much longer the use of armor on huge floating fortresses, to any such extent as in the past, is to be continued by civilized nations. Nothing can be more certain than that the years immediately before us are to witness most profound changes in methods of warfare and in international relations. No one knows what revolutionary alterations in methods of national defense are to result from the development of the submarine, the airship and the controlled torpedo.

Of course, if the Government were obliged as a matter of national defense to incur this risk of obsolescence, there would be no question as to its duty to do so, be the cost smaller or greater. But the Government has avowedly undertaken to build its own armor-plate plant solely because it has concluded that it can save money by making its own armor on the previously mentioned estimate of $230 per ton for operating expenses instead of purchasing armor from the Bethlehem Steel Co. at its offer of $395 a ton. The Bethlehem Co. has now offered, however, to submit its entire plant, accounts and operations to the Federal Trade Commission and to manufacture such armor as the Government may require at such a price per ton as the Federal Trade Commission, acting as an impartial umpire, may decide to be fair to the Government and to the company. If Congress is governed by business principles and not by politics in dealing with the armor-plate question, it will accept this latest offer of the Bethlehem Co. rather than invest $11,000,000 of the Government funds in an armor-plate plant, which may quite possibly need to be replaced with something very different within a few years after its completion.

Changes in Ocean Carriage

No better illustration could be given of the unprecedented conditions now prevailing in ocean transportation than the statement made last week, in a hearing before the Interstate Commerce Commission, that substantially none of the vessels which were plying between the Atlantic and Pacific Coasts through the Panama Canal at the time it was closed, last October, will be restored to that route now that it is reopened.

The demand for ocean shipping and the rate for ocean freights have so greatly increased during the past six months that the vessels which were making regular trips through the Panama Canal from ports on the north Pacific Coast to ports on the Atlantic can earn more money elsewhere.

There is no longer any need of railway transcontinental rates to Pacific Coast points being less than rates to intermediate distances on account of water competition. It is probable that this condition will continue for a considerable time. The tonnage of merchant shipping on the ocean, through the combined effect of natural losses and destruction due to war conditions is being reduced faster than it is being restored by the building of new vessels.

One of the industries most seriously affected by these abnormal conditions is the lumber trade of the north Pacific Coast, which is dependent on low transportation rates to reach the markets on the Atlantic. In an address before the Seattle Engineers Club on Apr. 20 Kenneth C. Kerr, editor of the *Railway and Marine News*, stated that some 20 wooden sailing vessels are now being built on Puget Sound from native lumber and are to be equipped with Diesel oil engines for auxiliary power. These vessels are built to carry lumber from the coast mills to remote markets. It was generally supposed a half-dozen years ago that wooden vessels and sails for ship propulsion on the ocean were both obsolete. With steel at present high prices and unobtainable for hull, engine and boiler construction except after long delays, the wooden sailing vessel is a most useful resource.

Handling High-Class Freight Traffic on Inland Rivers

The question whether water transportation can be revived on the inland rivers of the United States is one of great interest to the public and to the engineering profession. It is well known that commerce has practically deserted most of the inland waterway routes of this country. There are numerous causes for this, but the great and controlling cause is the development of the railway as a freight carrier.

To look back for a moment to the history of transportation development in the United States, the facts that the steamboat was invented nearly a generation earlier than the railway locomotive and that water routes had always been the natural avenues for commerce were responsible for the early development of steamboat transportation throughout all the settled area of the United States in advance of the construction of railway lines. Further than this, it was not until the railways had been in operation for half a century that the cost of railway transportation was brought down to a point where the railway could begin to become a serious competitor of the steamboat in freight haulage. In the last forty years the railway has been marvelously increasing its efficiency as a carrier, while inland water-transportation methods and machinery have been practically stationary. The result is that there are very few inland waterway routes which are today carrying sufficient commerce to justify the investment which the Federal Government has made in their improvement.

Can commerce be restored to these waterways? Certainly not by pursuing the methods of the past. It hardly needs demonstration that, while the old-time river steamboat could compete with the railway as it was in 1850, it is hopelessly outclassed by the railway as it exists today. Those who believe in the possibilities of restoring water traffic, therefore, have long been on the lookout for some new methods and apparatus for water transport to meet the needs of the present day.

On Apr. 15 a new type of freight carrier began running on the Mississippi River between St. Louis and New

Orleans, and a detailed description of the vessel appears elsewhere in this issue. Even more important than the boat itself are the business organization and system of which the boat is a part. First and foremost, the new enterprise is organized and directed by an engineer, J. H. Bernhard, who has applied engineering methods to the work on which he has been engaged for several years past—the revival of river transportation.

It is pretty well known that such traffic as still remains on inland waterways is chiefly bulk freight of the lowest value. Even when the commercial tonnage on a river makes a respectable showing in the statistics, investigation usually shows that most of the tonnage is made up of sand, gravel, stone, logs, lumber and coal. Most of the freight on the Ohio River, for example, which has been made much of by the defenders of water transportation, consists of coal loaded from mines on the Monongahela River into cheap barges and floated downstream, during a rise in the river, to a market in New Orleans. Such methods of transportation do indeed show a phenomenally low cost of transport per ton-mile, but they are applicable in so limited a way that they can have little effect in restoring inland waterways to a commanding position in handling internal commerce.

While the cost of hauling these low-value bulk freights in river barges is very low, the cost of handling them at terminals is apt to be heavy; and the railway with its hopper-bottom cars, which are able to carry a load without transfer from origin to destination, can often show economy over the water route if a transfer to rail or wagon haulage has to be made at one or both ends of the boat's trip.

For these and other reasons the new boat line that Mr. Bernhard has inaugurated on the Mississippi is designed to carry not the low-value bulk freights, but the highest class of merchandise freights. The rates on this class of freight are high enough so that the cost of transfer at one or both ends of the boat journey is a small percentage of the total rate compared with the cost of transferring bulk freight. The reasons why Mr. Bernhard's new boat has a good chance of succeeding in its competition for merchandise freight that the old-fashioned type of river vessel has lost to the railways are not because Mr. Bernhard's barge is of steel while the old boats are of wood, not because his barge is propelled by oil engines while the old-time boats are propelled by the ancient stern wheels and antediluvian steam machinery, but because Mr. Bernhard, through his boats and his organization, purposes to furnish to the shipper a *reliable* and prompt transportation service, involving a minimum of risk.

The first barge put in service will be followed by three others during the summer. The Inland Navigation Co., which has built and is to operate these barges, is capitalized at $9,000,000 and plans to have 36 barges of 1,600 to 5,000 tons' freight-carrying capacity in service by the spring of 1918. The company announces that it will carry freight on a through bill of lading to any point in the world, and except for less than carload shipments and where the point of origin of the freight is not on a switch track, the company will absorb the switching charges at the point of origin, loading and unloading and the switching charges at the point of destination. The company also plans to absorb the cartage charges to and from the docks or wharves to the shippers' plants or warehouses in the river cities at which its boats land. Eventually, the company proposes to carry freight, including all the foregoing terminal charges, at 25% less than the all-rail rates. At present, however, as its service is incomplete and the expense in establishing the business is large, it will carry freight at a rate equal to the rail rate minus 25% of the company's net receipts from the traffic. Whether the company can make a commercial success of this business remains of course to be demonstrated. There seems every reason to believe, however, that it can carry at a material advantage over the rail service any freight originating and ending in the river cities where it operates.

One thing which may be well emphasized in connection with this subject is that the problem of reviving transportation on inland waterways is not, as is commonly supposed and generally claimed by the waterways advocates, a matter of securing further stupendous appropriations from the Federal Government for river improvement.

The waterways are there; and the depth of water in them is sufficient. If water transportation is revived in the United States, it will be by building such types of vessels and such forms of apparatus for handling freight where the vessels make landing and by operating both facilities in such an economical and businesslike manner that traffic will resort to the waterways because of their economic advantage.

⁂

A dozen years ago the late John A. Hill, at that time the publisher of the *American Machinist*, wrote for the advertising pages of that publication a series of essays on the ethics of good advertising. These essays contained so much sound sense and represented such advanced ideas in the ethical conduct of advertising—ideas which at that time were comparatively new, but since then have been, thanks largely to Mr. Hill's influence, widely adopted—that it has seemed to us worth while to reprint these articles in *Engineering News*. The first of these essays appears in this issue on the second advertising page, and the others will follow in succeeding issues.

The essays are modeled after the well-known "Letters of a Self-Made Merchant to His Son." The style in which they were written, with its short, crisp sentences, was characteristic of Mr. Hill. It need hardly be said in these columns that he thoroughly believed in and practiced himself the policy that he preached. The first essay, as will be seen, is chiefly devoted to the condemnation of the practice of knocking competitors in advertising. In his second essay, which will appear in our next issue, he condemns in the following terse sentences the practice of publishing puffs and trade write-ups, so called, in technical journals:

> **Keep out of papers that are free with the puffs. They will give a hundred-dollar puff to your competitor whom they hope to get as an advertiser and nullify the sixty-dollar ad you are paying for.**
>
> **A paper that spends time and money to interest its readers and is very, very chary about using any puffs or write-ups, for you or any other advertiser, is a paper to tie to.**
>
> **Even if it has the reputation of being mean about notices, stick, and put in your best puff in your regular advertising space. That's the paper that is read, and read by people who know an advertisement in disguise as well as they do a technical article.**

Letters to the Editor

Beams Without Lateral Support; Relations of Formulas

Sir—The writer read with interest in the Apr. 6 number of *Engineering News* the article discussing beams without lateral support. Mr. Fleming has made a very comprehensive review of the formulas in present use. It is a matter, however, like that of columns in general, which with the knowledge of the subject at present and the lack of data compiled from a complete and systematic series of tests does not lend itself to a solution which is entirely conclusive or satisfactory. It is a notable fact that the results of formulas and rules given by different authorities, when compared, are very divergent. This, from the nature of the problem, could naturally be expected.

A few months ago the writer made a little study of the subject in order to see what relation, if any, exists between formulas for lateral flexure of beams and formulas for columns. He cannot say that he has any definite conclusion on the subject to offer, but wishes to present at least a thought on the subject.

The American Railway Engineering Association's "General Specifications for Steel Railroad Bridges, 1910," gives the following formulas for unit stresses in columns and compression flanges of beams:

> Unit stress in axial compression on gross section of columns, $16{,}000 - 70\frac{l}{r}$, where l is the length of the member in inches and r is the least radius of gyration in inches.
>
> The maximum unit stress in the compression flange of any beam or girder should not exceed $16{,}000 - 200\frac{l}{b}$ when flange consists of angles only or if cover consists of flat plates. Here l is the unsupported length of flange and b is the width of flange, l and b taken in the same unit of length.

Other specifications giving the same value for the unit stress in columns as the specifications just quoted do not give formulas for the reduction of unit stresses in compression flanges of beams and girders. Instead, they state that the unsupported length of a compression flange should not exceed 12 times the width of the flange. In other words, the unit stress in a flange whose unsupported length is 12 or less times its width need not be reduced for lateral flexure. Practically all specifications and ordinary practice make the gross areas of the tension and compression flanges on girders equal.

We will now attempt to find what relation exists between the column formula $\left(16{,}000 - 70\frac{l}{r}\right)$, the formula for compression flanges of beams $\left(16{,}000 - 200\frac{l}{b}\right)$ and the specification which does not require any reduction in compression flanges of beams where the unsupported length laterally does not exceed 12 times the flange width.

The maximum flexural stress, due to column action, developed in the flange of a beam that is unsupported laterally and carrying a uniformly distributed load is produced in a column whose length is approximately two-thirds the length of the beam. The derivation of the value for this equivalent column length by use of Ritter's formula for columns is given by Mr. Hess, as referred to in Mr. Fleming's article. Mr. Hess gives the equivalent column length for a uniformly loaded beam unsupported laterally as seven-tenths the length of the beam. Mr. Fleming states that Professor Moore gives the value two-thirds for the same case. Then l, the equivalent column length, would have a value only about two-thirds as great as l in the formula $16{,}000 - 70\frac{l}{r}$. The value of the radius of gyration in terms of the width of flange varies from $0.22b$ for flanges without cover plates to $0.24b$ for flanges composed of angles and cover plates. Using an average value of $r = 0.23b$ and substituting $\frac{2}{3}l$ for l in the formula $S = 16{,}000 - 70\frac{l}{r}$, we get

$$S = 16{,}000 - 203\frac{l}{b}$$

or, using round numbers

$$S = 16{,}000 - 200\frac{l}{b}$$

the formula for compression flanges of beams.

If, as usually specified, the gross areas of the tension and compression flanges of a girder are equal, the net area of the tension flange for girders with cover plates is approximately 85% of its gross area, for rivet spacing ordinarily used in the greater part of the girder length, and in its middle portion. It then follows that the unit stress due to bending (neglecting lateral flexture) in the compression flange will have an intensity only 85% as great as that in the net section of the tension flange. This difference in the unit stresses for the two flanges will be available for taking care of the lateral flexure. If the bending stress in the net section of the tension flange is 16,000 lb. per sq.in., then the stress in the compression flange (neglecting stresses due to lateral flexture) will be $\frac{85}{100} \times 16{,}000 = 13{,}600$ lb. per sq.in. Then if the maximum unit stress in the compression flange, including lateral flexure, is not to exceed 16,000 lb., the allowance for flexure equals $16{,}000 - 13{,}600 = 2{,}400$ lb. per sq.in. But this flexural allowance of 2,400 is represented in the formula $16{,}000 - 200\frac{l}{b}$ by the last term. And if $200\frac{l}{b} = 2{,}400$, then $\frac{l}{b} = 12$.

In designing and using the formula $16{,}000 - 200\frac{l}{b}$ for compression flanges, if the unsupported length is made equal to or less than $12b$, no additional section need ordinarily be added to the compression flange. This is due to the fact that the difference in area between the

gross section of the compression flange and the net section of tension flange will be sufficient to compensate for the stress produced by lateral flexure, the magnitude of which is calculated by the previously mentioned formula. Naturally, the case where a horizontal thrust is carried by the girder flange is excluded from the above discussion.

HENRY KERCHER.

Cleveland, Ohio, Apr. 18, 1916.

Flood-Prevention Plans in Los Angeles County, Calif.

Sir—As described in your issue of Feb. 17, 1916, check or restraining dams have been recommended for experimental testing in the report of the Los Angeles County Board of Flood Control and to a limited preliminary extent have been tried out in Haines Cañon, which drains 3.9 sq.mi. of the western face of the Sierra Madre range in this county.

The flood problems of southern California are difficult and unusual, the most severe feature being the enormous quantities of débris eroded from the steep mountains. It must necessarily be deposited in the flood channels crossing the plains, which have flat gradients. In Switzerland and Germany check dams occasionally are used primarily, if not solely, for the purpose of preventing erosion rather than for the control of the volume of flood flow. The Board of Flood Control, of which the writer was a member, recommended to the Board of Supervisors of Los Angeles County that substantial appropriations be made for continuing experiments with these dams, to determine their merit either in the control of erosion or in the preventing of the synchronism of the flood waves from various parts of the same basin. Provided these experimental construction works are accompanied with careful observations of stream flow, suspended matter in floods, rainfall, etc., not only in the basins that are so protected, but also in adjoining areas of similar topographic features and exposure, the work will be well worth while.

The people of our western country are so progressive that they are prone to seize upon slender hopes and develop them beyond proper proportion. For instance, it has been claimed by some that the floods in the lowlands can be prevented by spreading the water on the broad gravel cones where the streams emerge from their mountain cañons, thus putting the water underground by percolation. This would be a consummation devoutly to be wished. Near Riverside, it has been found that, for 14c. an acre-foot underground waters can be stored which subsequently are worth from $6 to $10 an acre-foot. This is a good investment.

The flows handled in this way are either small floods or the ordinary discharge during periods of nonuse of the stream. The crest of a large flood wave cannot be so used, first, because of its violence and, second, because the muddy water will clog the absorbent gravels in the spreading grounds. The crest of the great flood of the San Luis Rey River in San Diego County emerged from its cañon with a depth of over 15 ft. and a mean velocity from the mountains to the sea of nearly 20 ft. per sec. The job of spreading waters in that mood would be rather hazardous.

It has also been claimed that by planting forests in the mountains floods can be prevented. The trees and brush are desirable, and forestry is properly advocated and sustained. Forests retard erosion. The basin that has a forest cover will have a better summer flow therefrom; but after the forest floor has been saturated through a period of rain, the culminating great precipitation which produces the flood from other drainage basins will also produce one of practically equal volume from the forested area.

There is danger of this same optimism now being applied to the arguments in favor of check dams, as described in your issue of Feb. 17. They probably will do good in preventing erosion on the mountain sides and in cañons. They may even prevent the synchronism of floods from different portions of a drainage basin, although this involves a delicate computation of velocities. No generalized statement can be made about this. Each locality must be studied and may or may not be benefited by treatment in this regard.

If a great flood is projected naturally and uniformly down its mountain cañon at the rate of 12 mi. per hr. and if by the construction of many of these proposed check or restraining dams on the upper or outer perimeter of the drainage basin the flow from that section may be stepped down to half that velocity, there are localities where this would result not in a reduction of the total volume of the flood discharge in acre-feet, but in a substantial reduction of the crest of the wave in cubic feet per second as it rises from its cañon mouth. This would be a substantial accomplishment. The possibility of its demonstration was the justification for the Board of Flood Control for Los Angeles County recommending an outlay of $500,000 to test it thoroughly.

However, I, for one, do not believe that these small check dams will "store" water either directly or indirectly underground to any such extent as to affect the volume of the total flood discharge or so as to obviate the necessity of levees across the lowlands. Unfortunately, many laymen are assuming this conclusion, and this is apt to delay and interfere with flood control rather than benefit it.

The idea has been seized upon as an easy way to prevent damages that are serious and destructive. I know of no river the flood from which has been controlled in any other manner than by levees, except that in some instances valuable regulation has been obtained by the use of large storage reservoirs, as at the Roosevelt reservoir on Salt River, Arizona.

Personally, I am in favor of giving these check dams a thorough test and have used my best efforts in arranging with the scientific departments of the Federal Government for careful observations and inspection of the localities where they are being tried experimentally. Unfortunately, up to date, with the exception of determinations of rainfall in a few localities in Los Angeles County, there has been no adequate measurement made of the effect of these check dams in restraining floods or débris in the places where they have been tried as compared to other adjoining localities where they have not. As far as I know, there is as yet nothing upon which one can base a fair judgment or conclusion as to their value in this region.

Forestation, spreading of storm waters on débris cones, the construction of surface storage reservoirs and the building of the small check dams in the higher portions of the mountains—all must be adopted in the conflict with the flood, on the one hand, and in preserving the

summer flow, on the other. Every resource and energy must be utilized to make successful issue in this conflict with the torrents. Even then the remaining problem is most grave and severe, calling for all the reserve of skill that is available. J. B. LIPPINCOTT.

1100 Central Building, Los Angeles, Calif.

Coefficients of Retardation in Kutter's Formula

Sir—In Mr. Horton's article in your issue of Feb. 24, suggesting coefficients of retardation in Kutter's formula, I noticed that values for use in the design of pipes are included. Any of the numerous exponential formulas when compared with the Kutter formula show that the value of n varies with the size of the pipe and, in a given size of pipe, with the velocity. Therefore, it is impossible to assign correct values of n for definite conditions of pipe (perfect, good, fair, bad) and ignore size and velocity. Kutter's formula was designed for use on open channels, being based wholly on tests made on open channels, and does not apply to flow in pipes under pressure, as is shown by the fact that it does not agree with an exponential formula derived from actual field tests of flow in pipes under pressure.

I am of the opinion that values of n lower than 0.012 found by tests on concrete linings are merely due to experimental errors to the extent of the variation from this figure. This opinion is based on the following evidence: The Ridenbaugh Canal, near Boise, Idaho, shows as nearly a perfect surface as can be imagined in a construction for commercial use. Experiments have been made on various reaches of this canal by a half-dozen different field parties. Don H. Bark found values ranging from 0.0095 (on a short reach 340 ft. long) to 0.0118 (on a reach 1,478 ft. long). W. G. Steward found values from 0.0112 to 0.0132. Eleven of his 13 tests show values above 0.012. B. P. Fleming found 0.0124 on a reach with one slight curve. The writer found 0.0121 on a tangent and 0.0129 on a reach containing both tangent and curves.

It should be borne in mind that this lining had cement mortar smoothed over the concrete with a steel trowel. No roughness appears at the expansion joints. The whole surface is practically one smooth unbroken sheet, as shown by Fig. 1.

FIG. 2. CANAL IN SOUTHERN CALIFORNIA, SHOWING MASS AND MINERAL DEPOSIT

This accumulates on smooth or rough concrete alike. Kutter's "n" is from 0.016 to 0.018 in these canals

Until the most recent years too low a value of n was used in the design of both concrete-lined channels and wooden flumes. The value of n recommended by Schuyler, Freeman and Stearns in 1907 for use in the design of open portions of the Los Angeles aqueduct in concrete linings would have been called absurd 20 years ago. This value (*Engineering News*, Vol. 57, p. 614) was 0.018.

Both J. B. Lippincott and the writer found numerous cases in southern California where the value of n in concrete linings exceeded 0.016, yet many textbooks still hold to values of 0.011 for "cement with one-third sand." This is the nearest thing to concrete mentioned and implies that no higher value of n should ever be used. As a matter of fact, it is doubtful if such a low value should ever be used.

The conditions that require using a value of n between 0.016 and 0.020 for concrete linings are, as a rule, not the fault of original poor construction. Moss and mineral growth and débris accumulations are generally responsible for such values, and these must be anticipated by the designer through his knowledge of the climate and waters (see Fig. 2). Rock ravelings are to be looked for wherever a lined canal is located on a hillside bench

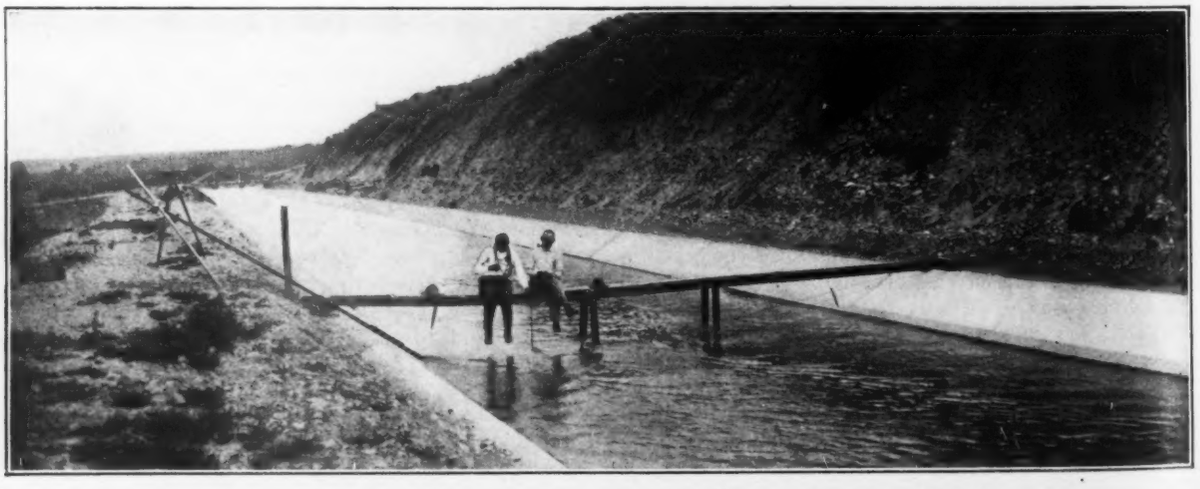


FIG. 1. THE CONCRETE-LINED RIDENBAUGH CANAL, NEAR BOISE, IDAHO

cut in rock, especially if no space is left between the upper canal wall and the side of the cut. Sand must be eliminated from the water, if the smoothness of the concrete or plank floor is to be relied upon for a high carrying capacity. There are many canals in southern California where the bottom is covered with sand to a depth of from 6 to 18 in. In such cases, of course, the lining merely prevents seepage losses and contributes nothing toward a high carrying capacity.

I would like to take this opportunity to correct the citations given by Mr. Horton at the end of his article. They should have read something like this:

Report of the Florida Everglades Commission; Bulletin No. 194, United States Department of Agriculture, "The Flow of Water in Irrigation Channels," by Fred. C. Scobey; Bulletin No. 194, Colorado Agricultural College Experiment Station. "Frictional Resistance in Artificial Waterways," by Cone, Trimble and Jones; and a staff article in "Engineering and Contracting," Jan. 27, 1915, taken from Bulletin 126, United States Department of Agriculture, "Concrete Lining as Applied to Irrigation Canals," by Samuel Fortier.

FRED. C. SCOBEY,
Office of Public Roads and Rural Engineering.
Washington, D. C., Feb. 28, 1916.

[Mr. Horton's comments on the foregoing letter follow.—Editor.]

Sir—The writer concurs in Mr. Scobey's opinion that values of n lower than 0.012 should not be used in designing concrete- or cement-lined channels. However, the writer's table was not intended merely to cover values to be used in designing, but also values to be used in the solution of other problems occurring in hydraulic practice. For example, where a diversion conduit has been built, it is sometimes necessary to estimate, in the absence of gagings, the maximum quantity of water which such a conduit will actually carry when new and in perfect condition. This question often arises in settlement of diversion damages. Under such circumstances it is desirable to have at hand the minimum values of the coefficient of roughness applicable to a perfect channel or conduit of the given type, although it would never be expedient to use the absolute minimum values in designing the conduit which it is desired shall assuredly convey a certain quantity of water. In general, in designing, the capacity should be such that the conduit will convey the required amount of water after it has been in use for a considerable period of time, and the joints and surfaces have become somewhat imperfect.

The writer's table was presented for the purpose of showing coefficients of roughness ordinarily applicable in the Kutter's formula in accordance (1) with the best accepted authorities and (2) with the latest experiments.

The writer did not attempt to present any argument as to whether or not the Kutter formula itself is the best one applicable to any set of conditions. It is a fact, however, that Kutter's formula is still very largely used in estimating the flow in pipes and conduits as well as canals and rivers; and while that condition remains, it is desirable that the best available coefficients of roughness for such conduits should be utilized.

Various exponential formulas for flow in pipes have been devised. In such formulas a constant coefficient, replacing the coefficient C in the Chezy formula, is commonly used. Theory indicates, and practice confirms the belief, that no formula can be devised involving only a single term or power of r and s in which the coefficient will be absolutely constant. While the use of exponential formulas eliminates the separate calculation of the coefficient C, yet it appears that the variation in the assumed constant coefficient C in such formulas actually is as great, or about as great, as the variation in the coefficient n for the same class of conduits. There is undoubtedly room for improvement in existing formulas for calculating flow both in pipes and in open channels. The laws of flow, where uniform or stream-line motion pertains, as below the critical velocity, are different from the laws of flow for sinuous motion at higher velocities. As long as single-term formulas are adhered to, it seems certain that difficulty will be experienced in devising any single formula for either pipes or channels which will give equally good results for both high and low velocities. Single-term formulas are, however, generally adhered to at the present time for two reasons: (1) Because they give greater simplicity of calculation than the two-term formula would give; (2) because there has accumulated a large body of data, especially with reference to the Kutter formula, which makes its application in many cases more certain than that of newer formulas, although this formula is less elegant from a theoretical viewpoint.

Attention should also be called to schedules Nos. 3 and 5 for "Natural Stream Channels." In some manner the coefficients for these two classifications became transposed. The correct values are as follows:

	Perfect	Good	Fair	Bad
(3) Winding, some pools and shoals, clean	0.033	0.035	0.040	0.045
(5) Same as 3, some weeds and stones	0.035	0.040	0.045	0.050

ROBERT E. HORTON.

Albany, N. Y., Mar. 18, 1916.

Engineers' Personal Interests Require Co-operation

Sir—In the Apr. 27 issue you published an editorial under the heading "Coöperate, but to What End?" This editorial is of a very unusual character, having in it a human interest that is in general altogether lacking in technical journals.

There are great pleasure and satisfaction in the work of an engineer. It is written in the Bible that man shall not live by bread alone. It seems today quite important for someone to emphasize that neither shall man live by work alone. The personal interests of engineers are in need of consideration. It is a matter of great importance that this thought has been borne in upon *Engineering News*.

The universally favorable comment upon the conference in Chicago and the extended space devoted thereto by technical journals bring home to the profession in a very emphatic form the personal need of the engineer.

It is clear that the writer of the editorial did not attend the conference, for he says "they went apart with no more definite purpose than to coöperate, somehow, in the future." No person present at the conference could fail to notice the intense interest in its proceedings by each of the men who were present, nor could he fail to observe that these men represented the best of the respective associations to which they belonged; and furthermore, he could not fail to note the decisive purpose pervading the remarks of all the speakers to achieve a betterment in conditions affecting the practice of engineering.

ALBERT J. HIMES.

Hickox Building, Cleveland, Ohio, Apr. 29, 1916.

Oil-Engine Driven Steel Barge for River Freight Traffic

A novel type of vessel for freight traffic on the Mississippi began running between St. Louis and New Orleans on Apr. 15 and has aroused great interest among those who look for a revival of traffic on the river.

The new vessel is the "Inco No. 1," built and owned by the Inland Transportation Co., of 52 Broadway, New York, and St. Louis. The President of the company and the moving spirit in developing this new craft and putting it in service is John H. Bernhard, Assoc. M. Am. Soc. C. E. Mr. Bernhard was also chiefly responsible for the design and construction of the steel barges, propelled by gas engines using gas from producers, which have been running for the past year between the Warrior River, in Alabama, and New Orleans. These barges are operated by the Alabama & New Orleans Transportation Co. and were described in *Engineering News* of Dec. 4, 1913.

In the new venture in Mississippi River traffic, however, Mr. Bernhard is aiming to carry not the cheapest

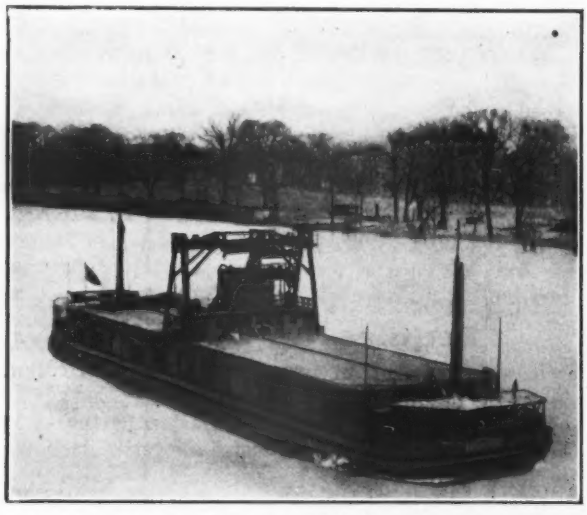


FIG. 1. STEEL BARGE PROPELLED BY OIL ENGINES FOR MISSISSIPPI RIVER TRAFFIC

class of bulk freight like coal, on which rates are very low, but high-class merchandise freight. The rail rate on this traffic is very much higher than on low-class bulk freight, and the boat line can make a strong appeal for such freight, not only on the ground of lower rates but of quicker delivery.

Of course, at times of car shortage like the present, shippers are eager to send goods by the boat line; but even under ordinary conditions the delays at railway terminals are such that a boat shipment from one city on the river to another will usually reach its destination in half or a third the time it would if sent by rail.

Merchandise shipments have been sent by rail instead of by boat, however, because the old river craft still in service are irregular and unreliable. Goods are roughly handled and poorly protected from the weather, from thieves and from fire, and in case of loss, recovery by the owners of the goods is more or less doubtful. All these conditions Mr. Bernhard hopes to change in his new type of boats, which are to run with regularity and are so designed as to reduce as much as possible the liability to accident and thus to popularize his service.

The new type of boat is a steel barge, with flat bottom. It is 240 ft. long, 43 ft. wide and with a draft of 9 ft. can carry 500 tons. At 7½-ft. draft it will carry 3500 tons. The barge is covered with a steel-plate deck protected by a wooden floor. The cargo is carried on this deck, nothing whatever being carried in the 6-ft. high space between the barge's bottom and this deck. This space contains steel posts which support the deck beams and at the same time form the verticals for five lines of longitudinal trusses. These posts also support transverse water-tight bulkheads which divide the hull into five separate compartments.

The advantages of carrying the cargo on the deck instead of in the hold are the much greater convenience of loading and unloading and the lessened liability to damage in case of leaks. Further, the longitudinal trusses previously referred to and the transverse bulkheads give the hull a strength and stiffness far beyond that of ordinary river craft.

To protect the cargo from the weather, the cargo deck has permanent sides with ten openings on each side closed by rolling steel doors, and a roof that is made in sections so that any section can be lifted off when it is desired to handle the cargo from the top.

Probably the most striking feature of the boat in its external appearance is a traveling bridge crane which runs on rails that extend along each side of the deck outside the deckhouse. A telescoping boom on this crane may be extended out on either side of the boat to a distance of 68 ft. and will carry a load of 3 tons.

The old-time Mississippi river steamboat carries a long heavy gang-plank swung from a spar at its bow, and as there are few river towns along the Mississippi that have any wharves, this long gang-plank is necessary to reach from the steamer to the river bank where a landing is made. The traveling crane on the "Inco No. 1" takes the place of the gang-plank. It can hoist any section of the roof, lift the cargo from the section beneath and transport it to the shore. It can also be used instead of davits for lowering boats. For handling cargo on and off the boats an electric truck is carried on board and other trucks are to be available at the landings. Electric endless-belt conveyors are also to be used to transport freight on and off the boat.

The barge is propelled by four 80-hp. Fairbanks-Morse oil engines burning a petroleum distillate of 29° Baumé gravity. Each engine has four cylinders, operates on the four-stroke cycle and drives a screw propeller 51 in. in diameter. The propeller has four blades bolted on a central hub. There are trap-doors in the floor of the barge, over the propellers. Through these doors the propellers can be reached and a broken blade removed and replaced with a new one as quickly as one could change an automobile tire. In tests, blades have been changed in 9½ min.

The engine room is at the stern, and the cook's galley is at the bow. When the boat is running without load, the extra weight of the engines in the stern increases the draft aft and reduces the draft forward, so that the propeller immersion is about the same with the boat light and loaded.

The engines are started by compressed air stored in tanks at 150 lb. pressure. An electric generator driven by silent chain from one of the engines furnishes current for lighting the boat and also for operating a dozen or

more electric motors used for various purposes on board. When the boat is stationary and it is desired to operate the generator to furnish current—for handling cargo, for example—a clutch on the propellor shaft is opened and the engine runs without driving the propeller. Electric current is used for all heating and cooking, and no fire whatever is allowed on board.

The barge is further equipped with three powerful searchlights—one at the bow, one at the pilot house and one at the stern; each of them can be operated from the pilot house. The combined power is 18,000 cp.

The boat has four balanced rudders aft of the propellers. In maneuvering, one side engine can run ahead while the one on the opposite side is backing. Further, to assist in swinging the bow, as in coming alongside or leaving a pier, there is an electric motor-driven rotary pump at the bow under control of the pilot, which can draw water from either side and deliver an 8-in. stream on the side opposite; the reaction of this jet exerts a strong force against the bow.

The boat is operated by a captain, mate, two engineers, two oilers, four deck-hands, cook, helper and two wireless operators, who act also as freight clerks—a total of 14 for a double watch. Instead of carrying its own gang of roustabouts for cargo handling, reliance is placed on the freight-handling force at the wharves where the boat will land.

There is a refrigeration plant on board capable of cooling a chamber of 6,000 cu.ft. capacity to a temperature of 31° when the temperature outside is 95°. The refrigeration plant is designed not merely to maintain a low temperature in the storeroom adjacent to the cook's galley, but enables the boat to handle butter, eggs and similar freight which requires refrigeration.

Appliances for protecting the boat against accident are especially complete. As already explained, the 6-ft. high space between the deck and the bottom of the barge is divided into four water-tight compartments which can also be made airtight, so that water could not enter the hull faster than it could force out the air contained, and by the provision of a small air compressor on board it would be easy to expel water if it gained an entrance. There are also connected with the water-tight compartments three powerful electric bilge pumps which may be put in operation by a switch in the pilot house and which are capable of discharging 8,000 gal. per min. Mississippi River boats frequently get out of the channel and run aground. The "Inco No. 1" carries 2,000-lb. anchors at bow and stern, and by the aid of powerful electric winches these can be made use of to haul the boat off if she runs aground. Another most unusual device for a Mississippi River boat is a gun similar to those used in the life-saving service for sending a line on board a wrecked vessel. The gun can shoot a line 1,750 ft. The barge carries two boats—a 20-ft. power launch capable of 22-mi. speed, which can be put into the water by the traveling crane in two minutes; also an ordinary rowboat. In the swift currents of the Mississippi it is often a difficult matter to carry a heavy line to shore for use in hauling the boat off a bar. With the life-saving gun, however, a line can be shot to shore and a boat's crew sent ashore to haul it in and draw a cable after it.

At each end of the barge is a telescopic wireless mast which can be quickly lowered when passing under bridges. The barge carries two wireless operators, so that it can be communicated with at any time from the offices in St. Louis and New Orleans. The captain regularly reports to these offices his position, speed, the weather, etc., and can promptly summon help in case of need. In addition, the accounting department is informed of the freight on board the boat before its arrival, and the time of arrival can be so closely gaged that a force of roustabouts to handle the freight can be on hand as soon as the boat arrives, without wasting time waiting for it.

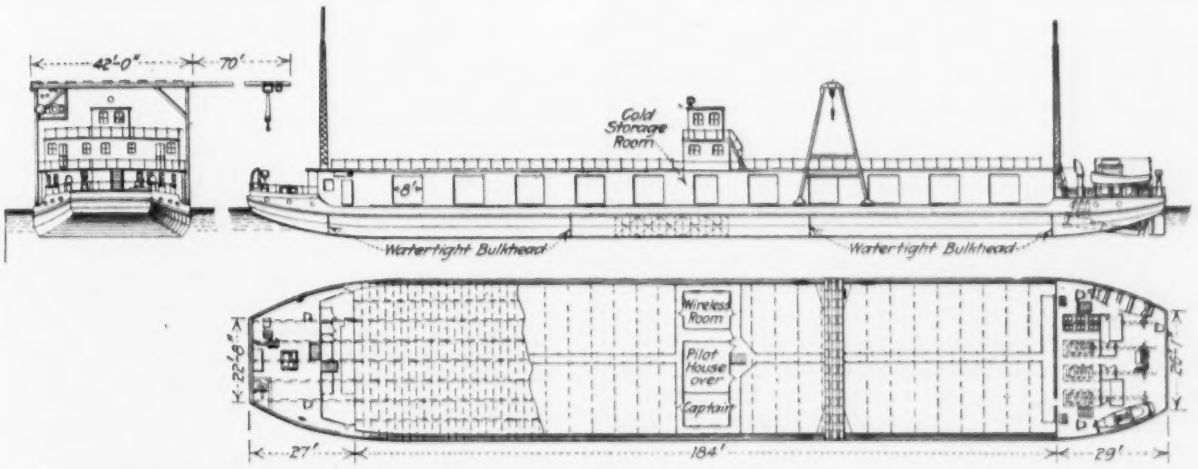


FIG. 2. PLAN, SIDE AND END ELEVATION OF STEEL BARGE "INCO NO. 1" FOR MISSISSIPPI RIVER TRAFFIC

The "Inco No. 1" surpassed the expectations of its designers in the speed which it made on its initial trip from St. Louis to New Orleans. The river was in flood and the boat had the aid of the current, but an average speed of 16 mi. per hr. was attained.

Three additional barges are under construction and will be placed in service this summer. The company plans to have 36 barges in service by the spring of 1918.

Raising a Town above its natural elevation is the method to be adopted at Milan, Ill., for avoiding flood troubles. For years there has been periodical flooding from the Rock River, causing property damage and unsanitary conditions. The present plan is to elevate the grade from 2 to 6 ft., raising the buildings and filling in all old cellars and basements to a corresponding amount.

Land-Drainage Project in Northern Minnesota

The reclamation of a large area of swamp land in northern Minnesota is to be effected by the construction of a system of 223 mi. of drainage ditches, known officially as "judicial ditch No. 25." This work will include also bridges, culverts and roads and a 17-mi. river-channel revision. The total cost will be over $500,000.

This drainage system, shown on the accompanying plan, will drain the basin of the headwaters of the Rapid River, an area of about 195 sq.mi. Practically all of this is Government land and is settled along the river, where natural drainage permits immediate development. The wet condition of this land is not due to lack of fall, but to the character of the soil, which is peat and muck, with sand ridges that impede natural drainage. The work will cost about $4 per acre. It is provided for by a bond issue and assessed according to benefits.

The regularity of the topography makes possible the location of ditches along the section lines, with an 18-ft. roadway on the spoil bank on the lower side of the ditch. There will be also a revision of the river, reducing 24 mi. of channel to a length of 17 mi., besides deepening and enlarging it to give adequate capacity for the discharge of laterals and the reclamation of rich bottom lands now subject to annual overflow.

Lateral and Cross-Drainage Ditches

The general plan of drainage consists of laterals 1 mi. apart, connected by cross-ditches at 2-mi. intervals. In the northern part of the area the laterals will run east to the river; in the southern portion they will run to the eastern boundary, where the water will be diverted to the north and discharged into a much more defined valley than that offered by the headwaters. As ample depth in the ditches is required to secure extensive lateral effect as well as to provide road material, this arrangement will relieve the river and consequently lighten the improvements necessary there.

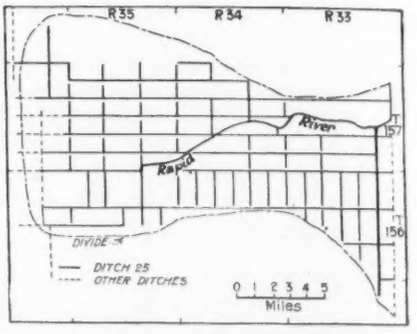
The liberal use of cross-ditches is required primarily for effective drainage, but it adds also to the efficiency of the road system. For the numerous ditch crossings thus required, pile bridges have been specified, with a view to the use of dredges in cleaning and the facility of placing permanent structures at a later period.

The average depth is about 7 ft. for lateral ditches and 6 ft. for cross-ditches. The base width is generally 4 ft., a 3-ft. width being specified only sparingly and in connection with grades sufficient to furnish a cleaning velocity. Frequent use is made of larger bases, particularly on the river, where the width ranges from 12 to 35 ft. The average excavation is about 14,000 cu.yd. per mi. The average depth of the topsoil is 4.5 ft., ranging from a few inches to 14 ft.

As no rainfall records or runoff measurements have been made within this territory, it has been necessary to use the data of neighboring stations. The assumptions are that an area of 10 sq.mi. should have a drainage outlet of capacity to remove $\frac{3}{8}$ in. of water in 24 hr.; while for an area of 200 sq.mi. the outlet capacity should be $\frac{3}{16}$ in. in 24 hr. In the design of ditches Kutter's formula has been employed with n equal to 0.025, while a value of 0.030 n has been used on the river-improvement design. However, in many cases conditions nullified the use of the formula, as where hydraulic efficiency is sacrificed for the more desirable elements of ample depth, road material and the added effect of drainage through the subsoil.

On account of the impassability of the country during the open season and the annoyance of great swarms of mosquitoes, surveys for this work must be made during the winter. A tent outfit is carried because of the sparse settlement and extended areas. The methods of preliminary survey were similar to those in general use throughout this section. Compass lines are started from the section corners and picketed through by axemen to the quarter-post, where a new line is started. Tapemen set station stakes, and levels are run, sea-level datum being used.

Soundings of the topsoil are made every 300 ft. along the lines, and the depth and character of the topsoil and subsoil are recorded. Notes of the timber (size, kind, cost of clearing and availability for construction purposes) are made at intervals frequent enough to include any appreciable changes. Every corner is referred to trees sufficiently far removed to escape cutting in the 66-ft. right-of-way. The present wood posts at corners will be replaced during construction by concrete monuments. Bench marks were placed every half-mile.



PLAN OF DRAINAGE DITCHES IN THE RAPID RIVER VALLEY, MINNESOTA

Drainage-Survey Methods; Winter Work

An efficient method of operation worked out during the prosecution of this survey eliminated all waiting of one party on another. Axemen in pairs, using pocket compasses to start them from the section corners, cut line in different localities fast enough to keep the untaped line well ahead of two tapemen, who were occasionally assisted in keeping ahead of the level by two axemen.

The entire party was thus separated into pairs, each of which was always "behind," save the axemen; and a natural rivalry among them to bring in the most line kept the work at top speed. Chainage was started from each section corner, permitting the chainmen to work on any line cut for them. Construction chainage must be run to place stakes corresponding to the chainage of the profiles.

The inconvenience of individual lunches, since no two pairs worked together, was overcome by the adoption of the "nose-bag" method of log drivers, each man selecting his own lunch after breakfast and packing it within his own coffee can, tying the whole in a small bag fitted with cords and wearing it on his back. The annoyance of the bag is negligible. The result of all hands working under pressure is an appreciable increase in the output of line.

The cost of surveys of this character has ranged from $10 to $20 per mile, varying with the growth of timber, accessibility of the region and like factors.

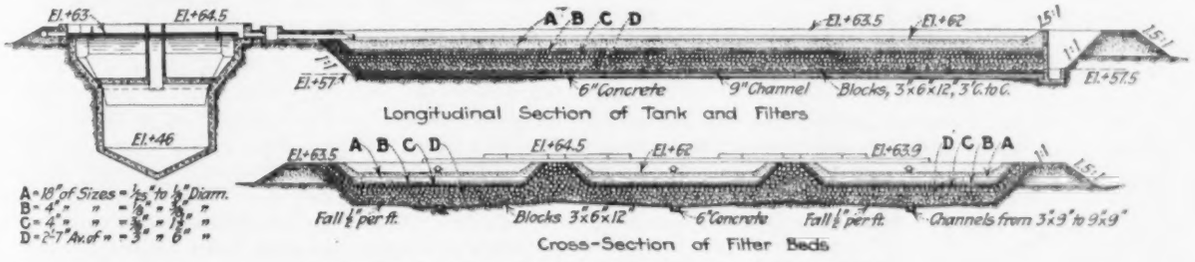
The soil soundings of the survey indicate that 5% of the topsoil is sandy loam, 10% is black and sandy loam of the river valley and banks, 55% is black muck and peat 1 to 5 ft. deep, and 30% is similar material 5 to 14 ft. deep. The subsoil is a glacial deposit of sand and clay.

The project has been divided into five divisions, so as to place the work within reach of the smaller contractors. Three of these divisions are best suited for floating dredges—namely, the river division of 23 mi. and two divisions of 37 and 40 mi. located in the areas of deep muskeg. Two sections, of 62 and 78 mi., can be handled by dry-land machines. Contracts will be let May 19 at Bemidji, Minn. The total cost, exclusive of roads, is estimated at $406,770.

The referee in ditch matters is O. L. Dent. For judicial ditch No. 25, A. A. Andrews is attorney, and John C. Burke, of Bemidji, Minn., is Engineer in Charge.

Imhoff Tank and Dunbar Filters at Ennis, Tex.

Dunbar filters to treat the effluent from an Imhoff tank are the unusual feature, for the United States, of a small sewage-disposal plant with a daily capacity of 200,000 gal., designed for Ennis, Tex., by N. Werenskiold, consulting engineer, Dallas, Tex. There will be two Imhoff tanks, a sludge-drying bed and three Dunbar filters.



SECTIONS OF DUNBAR SEWAGE FILTERS, ENNIS, TEX.

The accompanying sections through the bed show the size, depth and arrangement of filtering material. It will be noticed that the different layers of material are carried up the slopes. The filtering material is further described in the specifications, as follows:

The filter material must be of a durable class and free from dirt; it may be from good cinders, slag, coke, hard-burned brickbats, clinkers or a hard and durable rock or gravel and of sizes shown on plans. The bottom layer D may be separated from the mass by forking; the finer material in the supporting layers C and B, as also in the distributing layer A, by screening through suitable screens. To prevent early clogging, the upper layer A should preferably be of cinders or coke; but if these materials are not available, sand, screened from gravel, will answer the purpose, though cost of maintenance and cleaning will be greater. The lower layer should be placed as loosely and with as many voids as possible, in order to provide good ventilation, the principal purification taking place in this layer as the sewage trickles through it.

The Imhoff tanks are designed for a sewage flowing-through period of 2 hr., based on an assumed hourly flow of one-sixteenth the daily flow. The sludge-digestion chambers have an available space of 1.1 cu.ft. per capita, or both tanks are equivalent to 3,300 cu.ft. for 3,000 people. The filter beds have an available area of 2,400 sq.ft. each, or 7,200 sq.ft. for the three beds.

Mr. Werenskiold says that he has used a Dunbar filter at Weatherford, Tex., in connection with an old septic tank and that the filter has given good results for the period of a year and a half during which it has been in operation, the effluent being clear, odorless and stable.

Another Dunbar bed installed by Mr. Werenskiold as engineer is located on the grounds of the golf and country club near Dallas, not far from houses and right within the grounds. The effluent is discharged in a ravine that crosses the public highway just below the plant. Mr. Werenskiold understands that the results given by this bed have been satisfactory during the year it has been in use.

In general the only difficulty experienced in these beds, Mr. Werenskiold says, is the tendency for the upper layer to choke, if of sand. On that account he is going to use a dosing tank for a small plant now being built, where nothing but sand is available. In commenting further on Dunbar filters Mr. Werenskiold says:

The great advantages of these filters are that they are so very elastic. They will give good results for new plants, where the discharge gradually increases from nothing to a considerable amount in the course of a few years. They require comparatively little attention. The sewage can be turned on the bed to run for a week or two, till a film is formed and it fails to discharge the amount, then it is shifted on another bed, the first one rested, the film removed and surface raked up, if needed. Sprinkling filters seem unsuitable for small plants, and contact beds give none too good results.

Bids for the construction of the sewage works were received on Feb. 26 and ranged from $9,500 to $15,000. About Apr. 1 it was reported that the bids had been rejected and that the city would raise funds for sewer construction on the revenue to be derived from the sewers.

Ice Every Month in the Year was the record a century ago, according to extracts to notes sent to "Engineering News" by Carl P. Birkinbine, Parkway Building, Philadelphia. These notes are in the form of monthly summaries of weather conditions for the year 1816, extracted from a book published in 1847 by Charles Pierce, entitled "A Metereological Account of the Weather in Philadelphia from Jan. 1, 1790, to Jan. 1, 1847." The early months of the year were warmer than the average, but according to Mr. Pierce's detailed note there was ice ½ in. thick several nights in April and from ¼ to ½ in. thick "in exposed situations" some mornings in May. For June "there was said to be ice" one morning. In July, according to the record: "One frosty night was succeeded by another, and thin ice formed in many exposed situations in the country. On the morning of the 5th there was ice as thick as window glass in Pennsylvania, New York and through New England." Ice was also reported in August, September and October. For the entire year the "medium temperature" in Philadelphia "was only 49." Moreover, "it was the coldest summer ever known in the West Indies and in Africa," and it was also very cold in England.

News of the Engineering World

Bone Patent Case Dismissed

The case of Frank A. Bone against the Walsh Construction Co. for infringement of United States Patent No. 705,732 on a reinforced-concrete cantilever retaining wall was dismissed by Judge Wade of the United States District Court, at Davenport, Iowa, on Apr. 24. This date had been assigned for the trial last October, but when the case was called, counsel for the plaintiff filed a motion for continuance, basing the motion on the ground that his expert witness was otherwise engaged. He did not state who this witness was or what the general nature of his testimony would be. Inasmuch as notification of trial had been ample and the defendant was prepared, the judge overruled the motion and ordered the case to proceed to trial. Plaintiff then dismissed the case without prejudice, and was ordered to pay costs.

Rapid Transit for Cincinnati

By a vote of 39,726 for to 6,652 against, the City of Cincinnati, Ohio, on Apr. 25 approved the issuance of $6,000,000 bonds for the new rapid-transit scheme described in *Engineering News*, Apr. 6, 1916, p. 673. The main feature of the plan is a high-speed belt railway through the business district and following the line of an existing canal, which it is proposed to abandon. Part of the road will be in subway and part in open cut. Work will be started soon under the direction of F. S. Krug, Chief Engineer, Board of Rapid Transit Commissioners.

Cleveland Engineering Forces Are Reorganized

Although retaining Robert Hoffmann as Chief Engineer of the Department of Public Service of Cleveland, Ohio, somewhat extensive changes have been made by Director Alexander Beinstein in going down the scale. J. M. Estep, formerly Assistant Chief Engineer, has been dropped and his office abolished. The same is true of the position of Engineer-in-Charge of Rivers and Harbors, held by Edgar B. Thomas. Mr. Thomas was offered a position in the Sewer Department, but declined. The work in connection with rivers and harbors has been turned over to F. D. Richards, Bridge Engineer, who will rank next to the Chief Engineer. The position of Superintendent of Bridges, formerly held by John Dooley, has been dropped, and the work pertaining thereto given to G. E. Randall, Assistant Bridge Engineer. The Sewer Department has been put in charge of A. L. Stevens, who formerly was in charge of sewer construction; and G. A. Korell, formerly Assistant Engineer in Sewer Design, has been promoted to the position of Assistant Engineer in Charge of Sewer Design. The positions of Superintendent of Sewers and Foreman of Repairs have been abolished and the work will be put in charge of one engineer yet to be appointed.

Design for Road Signs Wanted

Designs for a guide to be used exclusively upon the state-aid roads of Illinois are invited by the State Highway Commission and must be submitted to the Commission, at Springfield, Ill., on or before June 1. The award will be made by July 1, and a prize of $25 paid to the person whose design is accepted.

It is specified that the sign must be simple, distinct, exclusive in design, not over 7 ft. high (when erected), and costing not over $25 complete, ready for erecting. It must be of metal or concrete and provide space for placing characters, letters and figures for giving the direction and distance to objective points. The design selected is to become the property of the Commission. Other designs submitted will be returned if requested. William W. Marr is Chief State Highway Engineer, at Springfield, Ill.

American $5,500,000 Contract for Work in Uruguay

One of the largest contracts ever placed with an American firm for work in South America is that for the construction of water-works and sewerage systems for the three cities of Salto, Paysandu and Mercedes, in Uruguay, which has been taken by the Ulen Contracting Co., of Chicago. The total cost will be $5,534,000, and it is expected to have the work completed in two years.

The cities of Paysandu (21,000 population) and Salto (22,000) are on the Uruguay River and respectively 70 and 112 mi. above Treyventos, which is the farthest river port reached by ocean steamers. The City of Mercedes (16,000) is 30 mi. up the Rio Negro. Materials are shipped directly from this country to Treyventos and thence transported by lighters and tugboats.

The water-supply is taken from the river in each case and pumped to settling basins, as the water contains considerable silt. The water is of good quality. It will be passed through sand filters and then forced by high-pressure pumps to the storage reservoir or tanks. At Paysandu and Salto each town will have two elevated steel tanks of 1,000 cu.m. capacity, while at Mercedes there will be a clear-water distributing reservoir of 200 cu.m. capacity. The distribution systems for the three towns will comprise about 1,000 mi. of 4- to 24-in. cast-iron pipe, or about 14,000 tons of pipe and special castings.

The sewerage systems will be on the combined plan, for both storm water and domestic sewage. There will be about 86 mi. of 8- to 22-in. concrete pipe, made in lengths of 39⅜ in., also 15 mi. of monolithic sewers from 24-in. diameter to 6.4x7.5-ft. egg-shape section. The sewage will be delivered to purification plants, including septic tanks and sand filters. The effluent in each case will be discharged into the rivers. The cement used is a local product, known as the Metzen portland cement,

which is manufactured at Montevideo. About 15,000 metric tons will be required.

The excavation is being done by two Marion steam shovels and two Buckeye trenching machines. The steam shovels have extension dipper handles for work on deep trenches and are equipped to operate also drag-line and clamshell buckets. For the concrete pipe plant there are two Blystone concrete mixers and a McCracken pipe-making machine. For the monolithic concrete sewer work there are four Marsh-Capron concrete mixers, from which the concrete is raised by Lakewood elevators and towers and spouted directly to the forms. Steel forms of the Hydraulic Pressed Steel Co.'s make are used. The 14,000 tons of cast-iron pipe and specials is furnished by the United States Cast Iron Pipe and Foundry Co. and the American Cast Iron Pipe Co.

The original plans for these works were prepared by a French firm, but have been revised by the engineering staff of the contracting company. The Stone & Webster Engineering Co., of Boston, acts as consulting engineer. Work was commenced on Apr. 1, and a large amount of machinery and material is now on the way.

Henry C. Ulen is President of the Ulen Contracting Co., First National Bank Building, Chicago. John R. Ulen is Vice-President, and C. M. Bonnell is manager of the company's bond department, which handles the financing of the contract. M. R. Keefe is Chief Engineer. The branch office at Montevideo is in charge of Earl C. Ulen, Vice-President, and Thomas Shepperd, General Manager; E. G. Trueheart is Chief Resident Engineer, and H. W. Hengst is General Superintendent of Construction. The company has sent down about 24 engineers, superintendents and foremen, and about 500 to 600 men will be employed when the works are in full progress.

Wood-Preserving Statistics

Statistics of the wood-preserving industry, collected by the American Wood-Preserving Association and the Government Forest Service, show that there was a material falling off in the industry in 1915 compared with 1914. This was due, doubtless, to the general inactivity in construction work during the first half of the year on account of war conditions and also to the difficulty in obtaining imported creosote. The total output of treated timber of various classes in 1914 and 1915 is shown in the following table:

Kind	1914	1915	% Increase or Decrease
Crossties, number.....	43,846,987	37,085,585	D. 15.4
Piling, lin.ft.....	11,920,600	9,308,420	D. 22.0
Poles, lin.ft.....	2,526,256	4,282,174	I. 69.5
Paving blocks, sq.yd...	2,616,903	2,937,132	I. 12.3
Construction timbers, ft., b.m.....	118,173,612	142,009,004	I. 20.0
Crossarms, number.....	674,273	146,188	D. 78.3
Lumber and miscellaneous, ft., b.m.....	16,347,408	13,937,508	D. 14.8

To treat the 141,858,963 cu.ft. of timber shown for 1915 required 80,859,442 gal. of creosote, 33,269,604 lb. of zinc chloride and 4,899,107 gal. of all other preservatives, which included crude oil, coke-oven tar, refined coal tar, carbolineum oils, etc. Of the creosote used in 1915, 54%, or 43,358,435 gal. (41,333,890 gal. coal-tar creosote and 2,024,545 gal. water-gas tar) was domestic and 46%, or 37,501,007 gal., German and English oil.

Two Headgates on the Welland Canal were carried out on Apr. 30, at Lock 8, by the wooden steamer W. J. Anerell, bound for Cleveland, laden with package freight. Vessel and towpath gate were carried out into the lower reach. Navigation was delayed for about 8 hr., and damage is estimated at $3,000. The accident was caused by the vessel not being properly checked by cable upon entering the lock.

An Explosion in the Garbage-Reduction Works of the Pacific Reduction Co., Los Angeles, Calif., on Apr. 23, injured seven men, three of whom soon died, and damaged the works to the extent of some $15,000. The presumption is that gasoline used in the process of treatment was ignited by cigarette or otherwise. The plant has a reported capacity for treating 250 tons of garbage daily. The Cobwell system is used.

A Bridge Accident Occurred on Apr. 17 near Deputy, Ind., about 40 mi. north of Louisville, Ky., on the Indiana Division of the Baltimore & Ohio Southwestern R.R. This division is used by the trains of the Big Four system, as well as the Baltimore & Ohio. A derailed car in a Big Four freight train hit an end post of a bridge over Graham Creek and caused the collapse of the span. The span was a single track, pin-connected, through-truss bridge 208 ft. 6 in. long. The depth of water in the stream at the crossing and other conditions made the work of restoring the line at the break comparatively slow, and it was necessary for several days to detour trains around the break over the Pennsylvania tracks.

An Old Iron Bridge in Tonawanda, N. Y., was damaged by a flood in Tonawanda Creek on Mar. 28. The bridge is known as the Webster St., or "Long," bridge and connects the towns of Tonawanda and North Tonawanda. The bridge was built in 1875 by the Wrought Iron Bridge Co., Canton, Ohio, had three pin-connected Pratt truss 100-ft. spans, with a 28-ft. roadway and a 6-ft. sidewalk on each side. The failure of the bridge was due to the scour underneath the east channel pier. This scour was aggravated by two canal boats that had been torn loose from their moorings and lodged against the pier. One end of the pier settled vertically about 5 ft., lowering the ends of the spans resting upon it by that amount and stopping traffic over the structure.

Bids for Constructing a Wood-Stave Supply Main for the new water-supply of Aberdeen, Wash., will be received on May 31. The conduit will be 28 in. in diameter and 22 mi. long. (See "Engineering News," Mar. 30, 1916, p. 603.) The contract for 1,000,000 of the 2,000,000 staves required has recently been let to the Vance Lumber Co. for $23 per 1,000 ft., f.o.b. Malone, Wash. The freight rate to Aberdeen is $1.20 per 1,000 ft. Louis C. Kelsey, city engineer of Aberdeen, is engineer for the new supply.

The Garbage-Incinerator Lawsuit against Atlanta, Ga., brought by the Destructor Co., New York City, has been decided in favor of the company. The Federal district court has ordered the city to pay the company $135,000 in addition to the $125,000 already paid. The court has also declared that the city is liable for operating expenses met by the company for a considerable period. The mayor, who has been against the contract for the incinerator ever since he took office, has declared that the suit will be appealed, and the company has announced that it will stop operating the plant. The mayor has contended that the contract was not fulfilled in that the operating cost exceeds 25c. per ton and in that the ventilation of the main building is defective.

The Shipbuilding Industry in the United States is experiencing the greatest activity ever known. According to statistics collected by the Bureau of Navigation of the Department of Commerce, there were, on Apr. 1, under construction or contract in shipyards in the United States 360 steel vessels with an aggregate tonnage of 1,067,856 tons. Of these ships 176, with a tonnage of 823,651 tons, were ocean-going vessels, and 184 vessels, of 244,205 tons, were for use on the Great Lakes and inland rivers. The largest tonnage in any yard was that of the Union Iron Works of San Francisco, 151,458 tons. The New York Shipbuilding Co., Camden, N. J., had 126,305 tons; the Newport News yard, 119,521 tons; the American Shipbuilding Co., Cleveland, 93,800 tons.

Contracts for Two Miles of Subway Construction will soon be submitted for bidding by the Public Service Commission, New York City. These contracts comprise three sections—1, 4 and 5—of the new 14th St.-Eastern rapid-transit line, which is to be operated by the New York Municipal Railway Corporation. Section 1, which is 2,889 ft. long, extends from Sixth Ave. to Irving Place, in Manhattan, along 14th St. Section 2, east of here to the river tunnel, has not yet been made ready for bidding; Section 3, the river tunnel, was let recently. Section 4, which is 3,590 ft. long, extends along North 7th and Metropolitan Ave. from Bushwick to Manhattan Ave. Section 5, which is 3,620 ft. long, extends along Metropolitan and Bushwick Ave. from Manhattan Ave. to Meserole St. The subway is to be two-track and must be completed ready for operation, in 22 months from date of contract.

The Standard-Barrel Law, which was enacted by Congress a year ago and goes into effect on July 1, fixes the capacity of a standard barrel at 7,056 cu.in. (4½ cu.ft.) for all dry commodities other than cranberries. This classification includes of course such materials as lime and cement. Lime manufacturers have already had introduced into Congress a bill establishing standard lime barrels of large size and small size, the large barrel to hold 280 lb. and the small barrel 180 lb. No action appears to have been taken by the cement manufacturers, however, and unless some special legislation is enacted before July 1, a manufacturer using the old cement barrel containing 3.69 cu.ft. is liable to the penalties fixed by the law. Probably the reason why the cement manufacturers have not taken more interest in amendatory legislation is that only a very small amount of cement is shipped in barrels nowadays.

Sewage Disposal for Los Angeles County, California, will go without further study for a time at least. In January the County Board of Supervisors appointed a Commission of Sanitation Engineers to report on sewage disposal for the whole county. The commission soon reported that an investigation of the subject would take a year and cost $45,000, including salaries of $3,000 for each of the five commissioners. (See "Engineering News," Feb. 24, p. 382, and Mar. 9, p. 486.) The supervisors appear to have thought that the desired report could be made in a few weeks and for a slight expense. On learning that they were wrong and that Pasadena, South Pasadena and Alhambra appeared to be getting their joint sewage-disposal project (see "Engineering News," Apr. 13, 1916, p. 725) in such shape that it could not be blocked (the apparent chief object of the proposed investigation), the supervisors have called a halt.

Large Hotels Connecting with the Railway Terminals in New York City are under way. The Pennsylvania R.R. has just announced the projected construction through a subsidiary of the Hotel Pennsylvania in the plot just east of its Manhattan terminal, lying between 7th Ave., 32d St., 33d St. and the Gimbel store. This plot is 200x400 ft. in area and will be occupied by a 23-story hotel building eventually to have 2,200 bedrooms, though at present a 1,000-room capacity is planned. Communication through the basement will be made with the terminal and with the Seventh Ave. subway. Excavation work has already started. The New York Central lines already have built the Biltmore, opening into the Grand Central terminal on the east, and have announced their intention to erect a large, popular-price hotel to the west of the terminal, on the northwest corner of 42d St. and Lexington Ave. Such a hotel would also connect with the Diagonal station of the New York City subway system.

State-Aid Road Funds in Pennsylvania cannot be used to construct state highways in boroughs or in townships, according to opinions just rendered by William H. Keller, First Deputy Attorney General of that state. The effect of the decision is to make a clear distinction between state-aid roads and state highways and the money that can be drawn upon by the state to pay for each. State-aid roads in Pennsylvania are roads built one-fourth at the expense of the borough or township in which they lie, one-fourth at the expense of the county and one-half at the expense of the state. Heretofore some of the state highway funds have been used for constructing state-aid roads in boroughs or in townships. Hereafter, according to the opinion, all work on state highways must be paid for by the state out of money appropriated for the construction, maintenance and repair of state highways on the one hand, and on the other hand state-aid money must be used on roads that are not state highway routes.

Two New Salvage Companies have been organized for the purpose of raising and stripping sunken merchant vessels. One of these concerns is the Interocean Submarine Engineering Co., organized in Albany, N. Y., with $125,000 of 7% cumulative preferred stock and 10,000 shares of common. At first, this company will work along the Atlantic Coast, but it is proposed eventually to extend operations to all seas. The president is Rear-Admiral Colby Mitchell Chester, U. S. N., retired, and the principal financial backers are George F. Baker, Charles Sabin, Albert H. Wiggin, Percy A. Rockefeller and G. M. P. Murphy. The vice-president is Chief Gunner George David Stillson, U. S. N., retired, who was engaged on the work of raising the submarine F-4, near Honolulu. The offices of the company are in the Equitable building, New York City. The other concern is known as the Deep Sea Salvage Corporation. H. L. Bowdoin, Bayonne, N. J., who is president, says that with the aid of a steel diving suit his company will be able to work at depths of 600 ft. Mr. Bowdoin states that the Merritt-Chapman Wrecking Co. will furnish ships and men for the salvage work as soon as the Deep Sea Salvage Corporation is prepared to furnish the new diving apparatus.

Scholarship in Chemical Engineering—The Chemists' Club of New York City announces the establishment of a scholarship fund, the income from which, approximately $500 per year, is to be devoted to assisting financially deserving young men to obtain education in the field of industrial chemistry or chemical engineering. This scholarship has been endowed by Dr. Victor G. Bloede, a manufacturing chemist, of Baltimore. Its benefits will be open to properly qualified applicants without restriction as to residence, and may be effective at any institution in the United States which may be designated or approved by the Chemists' Club. Applicants must, as a minimum qualification, have completed a satisfactory high-school training involving substantial work in elementary chemistry, physics and mathematics and present a certificate showing that they have passed the entrance examination requirements of the College Entrance Examination Board or its equivalent. Preference will be given to young men who have supplemented these minimum qualifications with additional academic work, especially in subjects which will form a suitable groundwork for the more advanced study of applied chemistry and chemical engineering. All inquiries should be addressed to the Bloede Scholarship Committee of the Chemists' Club, 50 East 41st St., New York City. Applications for the academic year 1916-17 should be in the hands of the committee on or before June 1, 1916. The scholarship will be awarded and candidates selected and notified on or before July 1, 1916. Doctor Bloede, the founder of the Bloede Scholarship, was born in Dresden, Saxony, in 1849 and began his technical education at Cooper Institute in New York City. Later he established himself as a manufacturing chemist in Brooklyn. In 1873 he organized the Victor G. Bloede Co., of Baltimore, of which he is president. He has been prominent in philanthropic work for many years, having presented to the State of Maryland its first hospital for advanced consumptives.

PERSONALS

Mr. Ralph Hamlin, Assoc. M. Am. Soc. C. E., Chief Engineer of Pike & Cook Co., Builders, Minneapolis, Minn., has been elected Vice-President and Director of the company.

Mr. Claude S. Gordon, Pyrometer Expert of the Illinois Steel Co., South Chicago, has opened a private laboratory and will conduct a service department as Consulting Pyrometer Engineer.

Mr. J. W. Lee, Jr., who recently resigned as Publicity Agent of the Pennsylvania R.R., will soon move to New York City, where he will become associated in business with Mr. Ivy L. Lee.

Mr. J. D. Scott, formerly power salesman of the Portland (Ore.) Railway, Light and Power Co., has been appointed Assistant Engineer in the office of the General Superintendent of the company.

Mr. Paul Riston, Assistant Editor of the Reynoldsville (Penn.) "Star," has been elected City Engineer of Punxsutawney, Penn. Mr. Riston studied civil engineering at Princeton University for three years.

Mr. Henry W. Dun, Jr., Jun. Am. Soc. C. E., has resigned as Assistant Engineer in the office of the City Engineer of Albany, N. Y., to enter the Engineering Department of the Atchison, Topeka & Santa Fé Ry.

Mr. Milo R. Maltbie, former member of the Public Service Commission of the First District for the State of New York, has been appointed City Chamberlain of New York by Mayor Mitchel. Mr. Maltbie succeeds Henry Bruère.

Mr. Henry C. Lang, formerly connected with the Estimates Division of the Public Service Commission for the First District of New York State, has resigned to enter the employ of the Graves Engineering Co., Inc., New York City.

Mr. Alexander C. Brown, Jun. Am. Soc. M. E., Vice-President of the Brown Hoisting Machinery Co., Cleveland, Ohio, has been appointed General Manager of the company to succeed Richard B. Sheridan, M. Am. Soc. M. E., who recently resigned.

Mr. Clyde B. Aitchison, member of the Public Service Commission of Oregon, has resigned to become Solicitor of the National Association of Railway Commissioners at Washington, D. C. Mr. Aitchison became a member of the Oregon commission in 1907.

Mr. Joseph W. Hunter, M. Am. Soc. C. E., First Deputy Commissioner of the Pennsylvania State Highway Department, has automatically become Acting Commissioner of Highways on account of the death of Robert J. Cunningham, noted elsewhere in this issue.

Mr. W. H. Wood, recently in charge of the steam-boiler plants of the American Writing Paper Co., Holyoke, Mass., has been appointed Superintendent of Power Plants in the Electrical Department of the Baltimore & Ohio R.R., with headquarters in Baltimore. He succeeds T. F. Foltz, who recently resigned.

Mr. George B. Harley, formerly an Assistant in the office of the Publicity Agent of the Pennsylvania R.R., has been appointed Publicity Agent of that railroad. He succeeds Mr. J. W. Lee, Jr. Mr. Harley has been with the Publicity Department since June, 1914. Previous to that he was on the reportorial staff of the Philadelphia "Press" from 1908 to 1910, the Philadelphia News Bureau from 1910 to 1914, and from February to June, 1914, was on the staff of the Philadelphia "Public Ledger."

Mr. James E. Gibson, General Superintendent of the Kansas City (Mo.) Ry., has been appointed General Manager of the system. He entered the service of the Metropolitan Street Ry., Kansas City, in 1904, as clerk in the accounting department. In 1905 he was appointed Assistant to the President and in 1909 became Superintendent of the 48th St. and Harrison division of the company, where he remained until 1910, when he was appointed to the office of General Superintendent. He served in that capacity through the reorganization of the Metropolitan as the Kansas City Ry. Mr. Gibson is a graduate of the University of Missouri.

Mr. James H. Van Wagenen, Assoc. M. Am. Soc. C. E., who has been with the International Boundary Commissions for several years in charge of field parties engaged on the survey of the International Boundary Line between the United States and Canada, has been appointed Engineer to the Commissions, in charge of the direction of all the field and office work of the United States section of the Commissions. Mr. Van Wagenen graduated at the University of Missouri in Civil Engineering in 1908 and previous to his engagement with the Boundary Commissions was with the U. S. Geological Survey on topographic surveys in North Dakota, and later was an Assistant Engineer with the Illinois Highway Commission.

Mr. W. E. Skinner, Assoc. Am. Inst. E. E., President of W. E. Skinner, Ltd., Winnipeg, Man., has opened an office as Consulting Engineer at 415 Plymouth Building, Minneapolis Minn. For nearly 10 years Mr. Skinner was in the employ of the Westinghouse Electric and Manufacturing Co. at East Pittsburgh and Buffalo. He acted as Consulting Engineer for the Hawaiian Electric Co. from 1900 to 1904, at which time he entered the employ of the Canadian Westinghouse Co., Ltd., at Hamilton, Ont., and later was in charge of that company's Winnipeg office until 1907, when he organized the firm of W. E. Skinner, Ltd. Mr. Skinner has also for several years acted in a consulting capacity to the Public Utilities Commissioner of Manitoba.

Mr. Theodore Speiden, Jr., who was appointed Superintendent of the Chattanooga and Nashville divisions of the Nashville, Chattanooga & St. Louis Ry. the early part of this year, has been made Assistant General Manager of the road, with headquarters at Nashville, Tenn. Mr. Speiden entered the Engineering Department of the Louisville & Nashville R.R. in 1899. He was promoted in 1905 to the position of Roadmaster, which he held until 1914. The last two years of that time he was also in charge of the reconstruction of 14 mi. of the Lewisburg & Northern R.R., the only portion of that line built with the company's forces. In 1914 he was appointed Assistant Superintendent of the Chattanooga division of the Nashville, Chattanooga & St. Louis Ry., and in July, 1915, was made Superintendent of the division.

OBITUARY

Thomas J. Keane, Superintendent of Asphaltic Construction in the Pennsylvania State Highway Department and Assistant at the department's testing laboratory, died at his residence in Harrisburg, on Apr. 25. He had been connected with the State Highway Department since 1912. Previous to that time his home was in Pittsburgh.

Albert Frank Brewer, General Superintendent of the Oregon Short Line R.R. at Pocatello, Idaho, died from an attack of heart failure while visiting a friend in Cleveland, Ohio, on Apr. 17. Mr. Brewer had been connected with the Oregon Short Line for 20 years. Previous to that time he was Superintendent of Transportation of the Denver & Rio Grande R.R., at Denver. He was 54 years old.

Robert J. Cunningham, State Highway Commissioner of Pennsylvania, died at his home in Sewickley, Penn., on Apr. 26, at 56 years of age. He was born in Elizabeth, Allegheny County, Pennsylvania. For a time Mr. Cunningham engaged in newspaper work. In 1903 he was elected Comptroller of Allegheny County and served until 1906, when he was elected State Senator. He was appointed Highway Commissioner in 1913 by Governor Brumbaugh.

Charles Henry Preston, M. Am. Soc. C. E., Architect and Civil Engineer, died at his home in Norwich, Conn., on Apr. 18. Mr. Preston started his business career as a millwright. He spent five years as an apprentice and journeyman with the firm of McQuirk & Bacon, Architects and Builders, and then studied architecture at Northwestern University for several years. Mr. Preston built some of the largest buildings in Norwich and other Connecticut cities and during the past year had drawn plans for the new buildings constructed at Taftsville to replace those destroyed by a fire which occurred there a year ago.

ENGINEERING SOCIETIES

COMING MEETINGS

CANADIAN RAILWAY CLUB.
May 9. Annual meeting in Montreal. Secy., James Powell, P. O. Box 7, St. Lambert, P. Q.

RAILWAY DEVELOPMENT ASSOCIATION.
May 9-11. Annual meeting in New Orleans. Secy., H. O. Hartzell, B. & O. R.R., Baltimore, Md.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 9-11. Annual meeting in Chicago. Secy., Franklin H. Wentworth, 87 Milk St., Boston.

AMERICAN SUPPLY AND MACHINERY MANUFACTURERS' ASSOCIATION.
May 10-12. Convention in Pittsburgh. Secy., F. D. Mitchell, 1510 Woolworth Building, New York City.

TAYLOR SOCIETY.
May 11-13. Conference on scientific management in Cleveland. Secy., H. W. Shelton, Hanover, N. H.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 15-18. Annual meeting at Hotel Sherman, Chicago. Secy., J. G. Crawford, 702 East 51st St., Chicago.

NATIONAL DISTRICT HEATING ASSOCIATION.
May 16-19. Eighth convention in New York City. Secy., D. L. Gasgill, Greenville, Ohio.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
May 17-20. Annual convention in Galveston, Tex. Secy., H. S. Cooper, Slaughter Building, Dallas, Tex.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 22-26. Convention in Chicago. Secy., T. C. Martin, 29 W. 39th St., New York City.

MASTER BOILER MAKERS' ASSOCIATION.
May 23-26. Annual meeting in Cleveland. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN IRON AND STEEL INSTITUTE.
May 26-27. General meeting in New York City. Secy., J. T. McCleary, 61 Broadway, New York City.

NATIONAL CONFERENCE ON CITY PLANNING.
June 5-7. Conference in Cleveland. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
June 5-9. Convention in New York City. Secy., J. M. Diven, 47 State St., Troy, N. Y.

MASTER CAR BUILDERS' ASSOCIATION.
Annual meeting, Atlantic City, N. J., June 14-16, 1916. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 14-17. Eighth semiannual meeting. Cleveland. Secy., I. C. Olsen, Cooper Union, New York City.

SOCIETY OF RAILWAY CLUB SECRETARIES.
June 16-17. Annual meeting in Atlantic City. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION.
Annual meeting, Atlantic City, N. J., June 19-21, 1916. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

TRI-STATE WATER AND LIGHT ASSOCIATION OF THE CAROLINAS AND GEORGIA.
June 21-23. Annual convention at Isle of Pines, S. C. Secy., W. F. Stieglitz, Columbia, S. C.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 27-30. Annual meeting in Pittsburgh. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

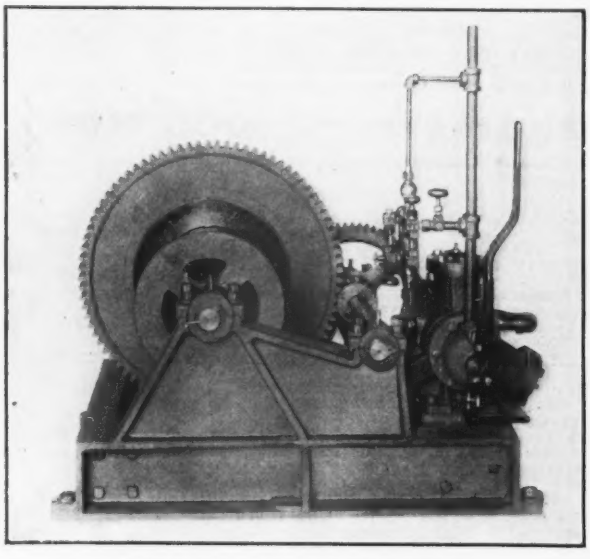
AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-30. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

American Society for Testing Materials—The annual meeting will be held at the Hotel Traymore, Atlantic City, N. J., June 27-30, 1916, the last session being held Friday afternoon instead of Saturday morning, as has been the recent custom. The provisional program shows three sessions on Tuesday and two each on Wednesday, Thursday and Friday. The nominating committee has announced the following nominations: President, A. A. Stevenson; vice-president, S. S. Voorhees; executive committee, W. H. Bassett, John Brunner, G. W. Thompson, F. E. Turneaure. The following officers hold over for another year: Vice-President, W. H. Bixby; executive committee, J. H. Gibboney, W. K. Hatt, J. A. Mathews, Edward Orton, Jr.

Appliances and Materials

New Two-Speed Hoisting Engine

A new two-speed hoisting engine has just been developed by the J. S. Mundy Hoisting Engine Co., Newark, N. J. The engine has three 3½-in. cylinders (2½-in. stroke) 120° apart, with connecting-rods coming to a single pin on a crank disk. It is designed to run under constant steam pressure (100 lb.),



NEW MUNDY TWO-SPEED HOIST

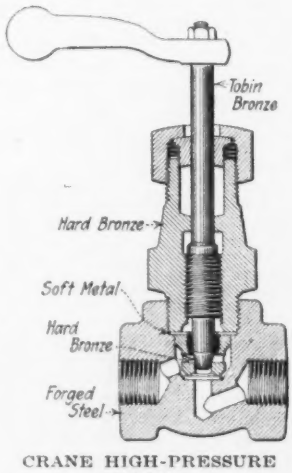
at constant speed (500 r.p.m.) and is particularly light, compact and portable, being 40 in. long, 25 in. wide and 32 in. high.

The engine is geared 31:1 for boom swinging. The maximum line pull is 2,000 lb. at 40 ft. per min. rope speed. The drum is 10 in. in diameter by 12 in. long and is on a $2\frac{3}{16}$-in. shaft. The complete hoist weighs 1,000 lb.

* * *

High-Pressure Valve

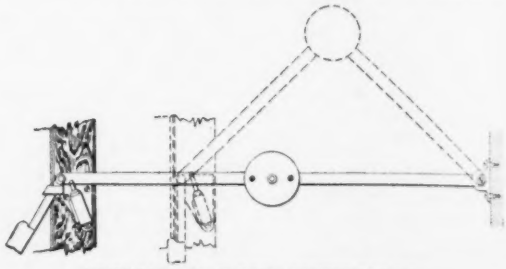
A line of forged-steel globe and angle valves has been designed by the Crane Co., Chicago, for hydraulic pipe lines, compressed-air and gas containers, engine-starting air systems and other extreme-pressure service. They are designed for hydraulic installations having 6,000 lb. per sq.in. working pressure not subject to shocks and to 3,000 lb. subject to extreme shock. The accompanying sketch shows the construction. The body is of forged steel liberally proportioned. The bonnet is of tough close-grained bronze. The stem is of rolled Tobin bronze or Monel metal; a lever handle is required. A renewable seat bushing is used, of hard bronze or Monel metal; this slips into the body, bearing on a soft-metal gasket at the bottom and having another soft-metal gasket between it and the bonnet. For sizes of 1 in. or less the bonnet has a hexagon section to facilitate removal; for 1¼-in. valves and larger the bonnet is bolted on. The stem ends in a long tapered plug that seats on the removable bushing; the thread is long and fine pitched. The stem has a shoulder that seats on the bonnet when the valve is wide open—permitting packing when the valve is open. The stock sizes range from ⅜ to ¼ in.; larger sizes are made to order.



CRANE HIGH-PRESSURE VALVE

Closer and Lock for Sliding Doors

A simple but effective device for automatically closing and locking elevator and other heavy rolling doors has been marketed by the Reliance Ball Bearing Door Hanger Co., 30 East 42nd St., New York City. As shown in the sketch, the device consists of two metal arms and a plain toggle joint and operates by means of a flat spiral spring and gravity. One end of one metal arm is pivoted to one side of a sliding door; one end of the other arm is pivoted to the door casing. The free ends of the two arms meet in the center in a toggle joint mounted in a flat disk containing a spiral spring. The two arms are in alignment horizontally across the door, and a horizontal pull at the lever handle breaks the joint, unlocking the door. As the door is opened and slid back, the arms rise with the disk at the toggle joint, forming an inverted V. When pressure on the lever handle is released, the



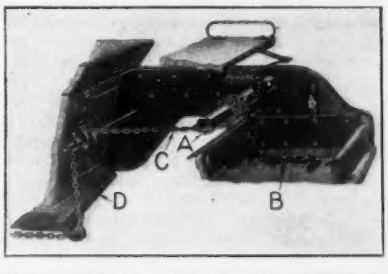
"RELIANCE" DOOR CONTROLLER

spring at the top of the V and the weight of the disk cause the door to slide silently shut and automatically lock as the two arms resume again their horizontal alignment. A liquid check reduces the speed of the door as it is about to close and eliminates all noise and jar.

* * *

Distributing Device for Dump-Wagons

To regulate delivery through the drop doors of dump-wagons built by the Studebaker Co., South Bend, Ind., the device shown is being used. The winding roller A has a chain B which can be slipped over a hook bolt in the platform at the driver's seat. This limits the revolution of the winding roller, so that the chain C holds the door D instead of over-



DELIVERY-CONTROL DEVICE FOR DUMP WAGONS

hauling and letting the door drop to its full opening. The hook is within easy reach of the driver from his seat, and by varying the length of chain between the hook and the roller the doors can be held at any width of opening, thus allowing the material to be distributed as the wagon moves forward.

* * *

Wearing Plates for Valves

In response to a demand for a steam or water valve that can easily and quickly be made tight without grinding, the O'Malley-Beare Valve Co., Chicago, has produced a design with the valve head and seat made up of superimposed uniform plates held by nuts. When a valve leaks from wear, the bonnet is taken off and a plate from both the seat and the head is removed. New plates can be put on, or the retaining nuts can be tightened up on the remainder. The multi-plate design is now made for all services; the plates are made of brass, composition nickel, Monel metal, etc.

* * *

Gasoline-Engine Starter

A new attachment for starting small gasoline engines has been devised by the Railroad Water and Coal Handling Co., Chicago. The scheme employed is first to inject a small quantity of explosive mixture into the compression space with the crank set just above the dead center and then to fire the mixture by moving the igniter. Compressed air for atomizing and injecting gasoline is supplied by a hand pump.